# EF 2000

ocean®

DID™
DIGITAL IMAGE DESIGN

TFX
MILITARY

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# PLEASE READ FIRST!

## COPYRIGHT NOTICE

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**Publisher: Ocean Software Ltd,**
**Eastgate, 2 Castle Street, Castlefield, Manchester**
**M3 4LZ.**

**Developer: Digital Image Design Ltd.,**
**Tannery Court, Tanners Lane,**
**Warrington, Cheshire, WA2 7NR.**

## DATA VALIDITY

All data for EF2000 have been secured from public sources. DID stress that all simulated elements are our interpretation of the facts, and are intended for entertainment purposes only. Because EF2000 is still in development, some of the systems represented in the game may not be associated with the real plane. Any trade names or trade marks are the exclusive property of the respective manufacturers.

## CAUTION!

The CD-ROM that holds EF2000 can be damaged by mishandling. We recommend that even if you intend to run EF2000 directly from CD-ROM, you perform the full installation to hard disk once and make a back-up copy using back-up software.

## EPILEPSY WARNING! READ THIS BEFORE PLAYING EF2000

A very small percentage of individuals may experience epileptic seizures when exposed to certain light patterns or flashing lights. Exposure to certain light patterns of backgrounds on a television screen or while playing computer games may induce an epileptic seizure in these individuals. Certain conditions may induce undetected epileptic symptoms in persons who have no history of prior seizures of epilepsy. If you, or anyone in your family, has an epileptic condition, consult your doctor prior to playing. If you experience any of the following symptoms while playing a computer game: dizziness, altered vision, eye or muscle twitches, loss of awareness, disorientation, any involuntary movement, or convulsions, IMMEDIATELY discontinue use and consult your doctor before resuming play.

## PACK CONTENTS

Accompanying the manual inside this box you will find one CD-ROM, a guarantee card and an EF2000 Poster. Please remember to return your guarantee card, and fill in the questions. This gives us clues for developing the products you want in the future.

## QUERIES

If you should find either the program or the documentation unsatisfactory in any way, don't hesitate to drop us a line detailing in full the reasons for your dissatisfaction. This will help us to avoid repeating any similar problems in the future. Opinions and complaints should be sent to:

**The Project Manager, EF2000,**
**Digital Image Design Ltd., Tannery Court,**
**Tanners Lane, Warrington, Cheshire WA2 7NR.**

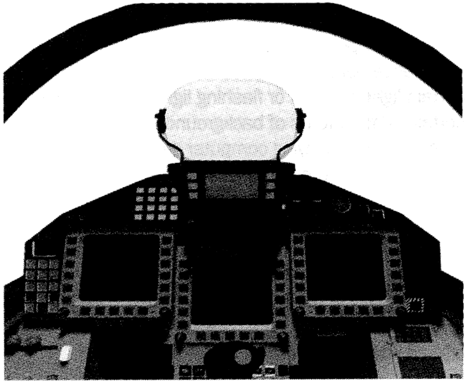
# EF2000 WELCOME

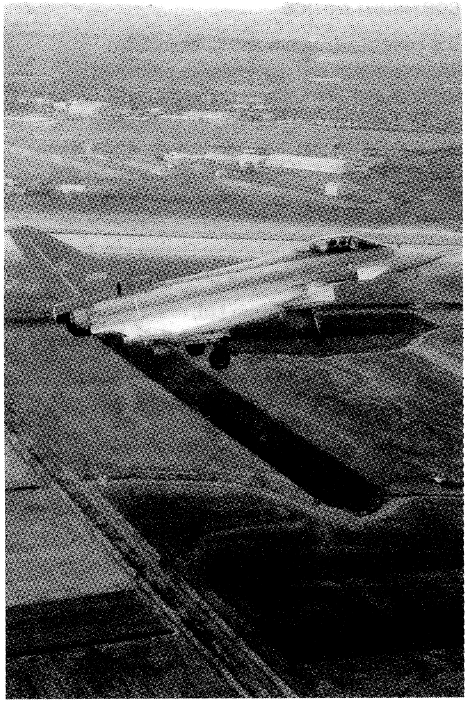
## VIRTUAL AIR COMBAT IN THE NEXT MILLENIUM

Welcome to EF2000. Since the release of TFX in 1993, we received a lot of compliments and a lot of suggestions for creating better flight sims (so many thanks to all those who took the trouble to write). We listened, and this time around decided to create the most believable, multi-player simulation of modern air combat ever seen.

Early on, we knew it was important to focus on quality rather than quantity, so we modelled the EF2000 and one combat environment with as much detail as possible. But don't worry, EF2000 has over thirty different planes with accurate flight models and 'smart' wingmen, plus more than four million square kilometres of texture mapped scenery to fly in. Add to this hundreds of other 3-D objects in target-rich locations, an AI controlled wargame, and network play for up to eight pilots, and you have a simulation that impressed even the plane's makers.

EF2000 would have been impossible to create without the help and advice of key institutions and their publicity departments, organisations and individuals. Among them is The British Aerospace Publicity Department, GEC-Marconi, The Royal Aeronautical Society, the Royal Air Force, and the publishers Key Press, who so kindly helped with information and aircraft illustrations by people like the renowned Mike Badrocke. Nor will we forget the support and encouragement of our publishers Ocean, who share our enthusiasm for flight simulation (especially when they are produced on time). For a full list of credits, see 'Who's Who'.





# EF2000 FEATURES

## EF2000 – THE NEXT GENERATION

Like the real EF2000, this simulation was designed to be different, to be the best in its class. Here are just a few of the features that we added with that goal in mind. . .

### AN IMPROVED VIRTUAL COCKPIT

We threw out the traditional approach to PC cockpits and built a full 3-D 'virtual cockpit' that's as close to the real thing as possible with current technology. We squeezed an enormous amount of information into a small area without sacrificing too much realism. So now you can glance down at full-screen displays, look over your shoulder and launch an ASRAAM in a close-turning dogfight, or be amongst the first to test your skills in beyond-visual range combat using the top-secret ECR-90 radar and S-225 stealth missiles. And for anyone with fast machines, our SVGA mode delivers visuals that come close to costly military simulations.

### A FRIENDLIER INTERFACE

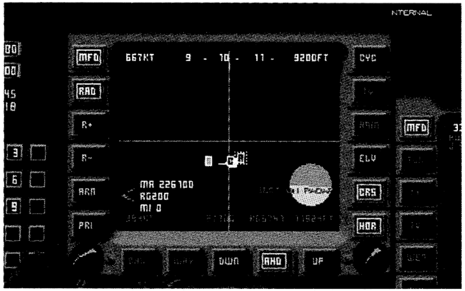
We felt our interfaces should be fun to use, without getting in the way of what you want to do. After a while, most pilots just want to hit a few keys to get to their favourite part of the simulation. So EF2000 offers an easy-to-use menuing system that lets you get around fast, but offers plentiful game choices and greater flexibility in configuration.

### IMPROVED PILOT AI

A great deal of time has gone into perfecting the way that computer controlled planes fly. We turned to the best books for advice, like R.E. Shaw's 'Fighter Combat and Manoeuvring', and some of the best pilots. Jaguar units at R.A.F. Coltishaw provided us with expert advice on single-seat ground-attack missions, while an ex-F4 pilot supplied the finer points of air-defence tactics, especially in Norway. The result is an enemy who will constantly gauge your movements and act accordingly, piecing together myriad textbook manoeuvres into fluid dogfighting tactics. For these reasons, you can expect the air combat in EF2000 to be tough but exciting. Learn how to use your weapons and wingmen correctly, and you will enjoy mastering one of the world's most advanced aeroplanes.

### UP-TO-DATE AVIONICS

Modern combat planes are getting so sophisticated that avionics designers are constantly searching for new ways to make the pilot's life easier. So instead of getting tougher to manage, modern combat planes will be easier to handle than ever. This trend is reflected in EF2000. You'll not only be amazed at what you can accomplish, you'll be surprised how easily it's all done.

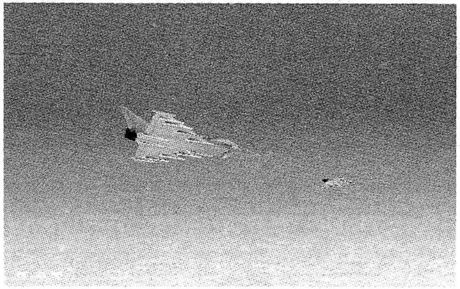


# EF2000 FEATURES

## EF2000 – THE NEXT GENERATION

### WINGMEN AT YOUR COMMAND

These days, few fly alone. In fact, air combat is all about multi-plane tactics, which is why we have developed a realistic method of wingmen control. And don't worry if you're a novice. The system has a beginners and advanced mode of control, to help you build confidence in commanding a flight of Europe's most advanced multi-role combat plane. In 'Beyond Visual Range' (BVR) combat, you'll discover that commanding wingmen and interpreting radar is a lot like playing 3-D chess. In close-up dogfights, you'll be glad of the extra help. You're going to need it!



### BETTER 3-D ENVIRONMENTS

Improvements in hardware and software mean that one day, in the not-too-distant future, we'll be able to offer 3-D environments that rival those of the best military simulators. EF2000 already includes radical improvements to our 3-D engine, which provide highly detailed and realistic static scenery and moving objects. Furthermore, we have texture-mapped the entire world of four million square kilometres - and it's not all the same. Far from it. Check out the fjords in Western Norway. Zoom low over the marshy lowlands of Finland. Skim the dense forests and snowy mountain regions of the North Cape. EF2000 is also a 3D travel brochure! You'll need some time, but fly around and enjoy the views.

### IMPROVED FLIGHT MODELS

Although EuroFighter is still a highly classified project, our aeronautical engineer has deconstructed available plans and created a flight model that's as accurate as possible in the circumstances (our consultant RAF pilots like it). We supplemented information from British Aerospace with US Datcom files on aerodynamics and pilot advice on practical fly-by-wire handling characteristics. What's more, we have carefully modelled the flight characteristics of allied and enemy planes, so you can expect planes like the MiG-29 to perform as they would in real life.

### NETWORKING FOR MULTI-PLAYER ACTION

Nothing is better than flying with or against another person. A great many TFX fans asked us to consider networking and serial communications in future products, and here it is. Up to eight players have access to our virtual combat environment, with several game formats to choose from. In fact multi-player EF2000 is so much fun, we strongly recommend you try it for yourself as soon as possible. Those of you interested in making a hobby out of it might want to contact Squadron XIII. They organise regular meets and competitions using networking flight simulation programmes.
For details, subscribe to 'ELO Magazine' in the back of this manual.

# EF2000 FEATURES

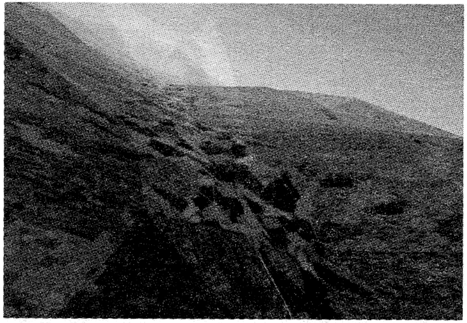
## EF2000 – THE NEXT GENERATION

### WARGEN - A MORE COMPLETE SIMULATION

A true simulator doesn't just model planes, weapons and scenery accurately. It must recreate the entire environment of conflict in order to create a true picture of how a modern multi-role aircraft might be used in future wars. In order to build this standard of realism into EF2000, we turned to the wargamers and military tacticians for input. By building our own 3-D wargaming engine that operates under AI control to a set of likely strategic conditions, we have been able to recreate the kind of tactical environments that EuroFighter was designed to fly in. Each time you play the campaign, you'll never see exactly the same moves by enemy or allies. Which means you'll be playing against our wargaming intelligence, not pre-determined game structures.

### BETTER SOUND

In the flying environment, sound is not just there for the atmosphere. In a real aeroplane, many cues are received from physical sensation in response to forces such as rapid deceleration. In a PC simulator, the least we can do is provide an audible cue to tell you that something is happening that you cannot feel or see; for example, that your airbrake is out, or that your afterburners are on. A great deal of time and effort has gone into the soundscape for EF2000, which we believe should add even greater depth to the gameplay. Listen carefully as you fly.



### SUPER VGA

At DID, we are aiming to produce flight simulations for the entertainment market that will rival military simulations costing a great deal more. One step towards this goal is adopting Super VGA as a standard. In EF2000, all menus are in SVGA, but in-game visuals are available in both 320 x 200 and 640 x 400 resolutions. Even if your machine is too slow for in-game SVGA, switch over and take a look at what you're missing. It's got to be worth an upgrade!

# THE EF2000

## WHY, HOW AND WHERE IT WAS DEVELOPED.

**GROUP CAPTAIN NED FRITH (RAF retired), head of EF2000 marketing at British Aerospace, ex-RAF test pilot and Operational Requirements Officer at the MOD explains a little about the background, development and specification of the EF2000.**

"The Eurofighter programme began in 1983, with a desire to produce an aircraft that could be used worldwide for defence well into the 21st century. This aircraft would be able to win against all current and projected threat aircraft.

The Eurofighter programme started life as a collaboration between UK, France, Germany, Italy and Spain. However, France ultimately pulled out of the programme, and the formal development phase began in 1988 in Spain, Italy, Germany and the UK. The EF2000 development was served by the Experimental Aircraft Programme (EAP), which was funded largely by the U.K. After extensive ground trials and 259 sorties, some at over Mach 2, the EAPs development work was complete in mid 1991.

# THE EF2000

## WHY, HOW AND WHERE IT WAS DEVELOPED.

EAP and other technology demonstrators played a key role in the development of the EF2000 and although they cost over £190m, they saved £850m and a year of development time, so they were undoubtedly a good investment. We learned a lot about the airframe, avionics and engine features from these demonstrators before commencing development of the EF2000.

A turning point in the programme came in 1992 at a meeting of the 4 countries' defence ministers at which they agreed "....on the essential elements of a political, strategic and economic approach to the new European Fighter Aircraft" They also agreed that the service entry point would be the year 2000 for the Royal Air Force and 2002 for the Luftwaffe, and the name EF2000 was created.

It is important to understand the requirement for the EF2000 in the context of the perceived threat. Defining this threat is the start point of any new military requirement and clearly no weapons system can claim to be successful, no matter how cheap, if it stands no chance of winning. Parity is not good enough.

Obviously, a great deal has changed since the threat was first defined for the development of EF2000. While there is no longer a direct threat from the Warsaw Pact, the risks to security are now many faced and even less predictable. The technology that made up the Warsaw Pact threat still exists and could still be used by those who inherited it, or by those who will buy it. Accurate

prediction becomes impossible, as was demonstrated by the fact that no one was able to foresee either the Falklands War or the Gulf War, even three months prior to the event. And one thing which became clear after the Gulf War was the dominant influence of air power.

A threat has two main elements, intention and capability. EF2000's service life could stretch from 2000 to 2035 and no politician can predict the intention of other nations even a few years in advance. Yet the certainty is that the developments of the MiG-29 Fulcrum and those of the excellent SU-27 Flanker could be available to an adversary. Whereas a military capability takes a long time to evolve, political change resulting in an intent can happen, relatively, overnight. It is therefore imperative that we continue in development of our response to any potential threat, and continue with the objective of winning.

EF2000 has always been a multirole fighter. Air superiority is required to provide a secure base, to defend airfields, troops and assets generally. Local air supremacy is required over the enemy territory to allow troops to take ground, and all the elements of Offensive Air Support will be needed to help the ground forces. Reconnaissance is required to assess threats. The EF2000 will be a multi-weapon platform providing for all these roles, whether on behalf of NATO or in other groupings, such as those in the Gulf conflict in which the RAF participated.

The EF2000 is a single seater, twin engined, delta canard, although a proportion of the fleet will be two seat, dual control. It has 13 store stations, three of which are wet, and an internal gun on the starboard side. The architecture will allow future 'smart' weapons to be carried with little modification. The main aerodynamic and thrust criteria for the EF2000 are determined by turning capability at high altitude and high supersonic Mach numbers, and by subsonic manouverabilty at sea level. It is from these criteria that the aircraft meets the requirement to operate from a short runway strip.

For air combat, a mixture of at least 10 future medium range and advanced short range missiles can be carried, with four of the medium range missiles housed in low drag, radar stealthy under-fuselage stations. For attack missions, combinations of seven air-to-surface weapons and six air-to-air missiles are possible, along with external fuel tanks and the internal gun. One of the under fuselage missile stations will be used when a laser designator pod is carried.

The two wingtip pods are an integral part of the wing and house part of the Defensive Aids Sub System (DASS) countermeasures equipment. EF2000 also has good radar stealth features. Besides the recessed weapons, the low frontal radar cross-section (RCS) is with a realistic operational load.

The airframe surface is only 15% metal. Extensive use has been made of load-bearing carbon fibre composites and aluminium lithium, resulting in a 30% weight saving over previous construction methods. This obviously has an important bearing on performance.

To operate from ill-prepared bases, the EF2000 has a strengthened undercarriage, built-in entry system for the pilot, an on-board oxygen generation system and an auxiliary power unit for running the nuclear, chemical and biological filter system and for the autonomous check out, alert and start up.

Unprecedented attention has been paid to the man/machine interface to allow pilots to think less about the operation of the aircraft and more about the tactics of the conflict. The quadruplex fly-by-wire control systems give the pilot carefree handling, ensuring that he cannot stall or overstress the aircraft. An intelligent Ground Proximity warning system (GPWS) further enhances the safety and operational capability. The pilot also has a button which will automatically return the aircraft to a wings level, nose up attitude in the event of disorientation after a high G force manoeuvre. This will undoubtedly save a number of lives and aircraft over the years.

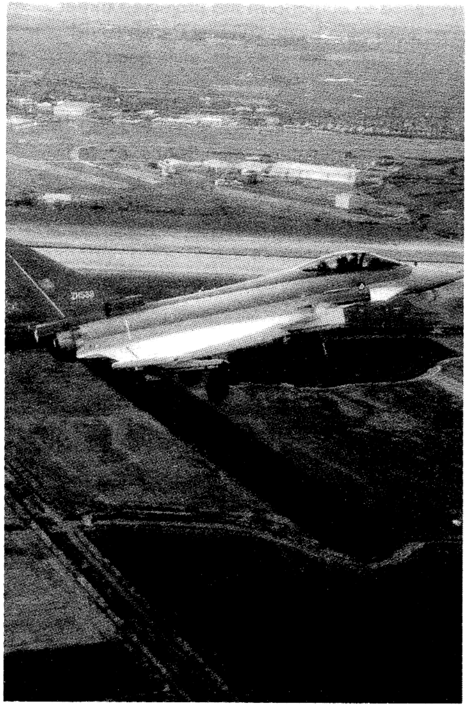
There is an advanced Infra Red Search and Track system (IRST) to compliment the ECR 90 multi mode Pulse Doppler radar with multi-track target-while-scan capability and high resistance to jamming. A helmet mounted sight and display will also help the pilot to exploit the new missile systems. With the Advanced Short Range Air-to-Air Missiles (ASRAAM) and the helmet sight, the pilot will be able to engage targets 'over-the shoulder'.

To make life easier for the pilot in the cockpit, all the important switches needed in combat are mounted on the throttle or stick. The holographic Head-Up Display (HUD) and three head down displays (HDD), which are viewable even in bright sunlight, help the pilot to assess the air situation easily.

Subsystem management is automatic with the pilot intervening only when absolutely necessary. Using Direct Voice Control for some non safety-critical systems, such as the allocation of targets or requesting the fuel state, further reduces pilot workload.

All in all, the EF2000 has been developed with the pilot in mind, requiring him to extend the minimum effort to digest the maximum information and enabling him to concentrate on the tactics of the conflict.

As I said earlier, parity with an enemy is not good enough. To this end, the EF2000 has been



# THE EF2000

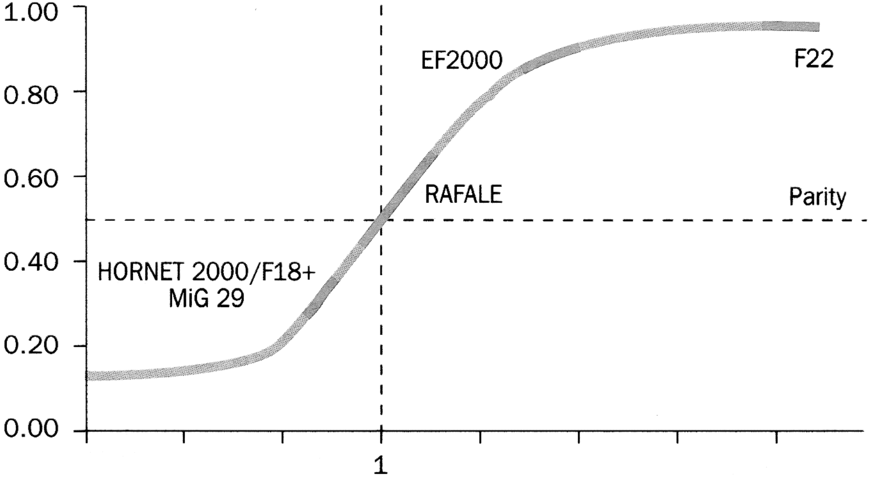
## WHY, HOW AND WHERE IT WAS DEVELOPED.

designed to outperform the projected threat aircraft in both Beyond Visual Range (BVR) combat and close 'dogfight' style combat.

Comprehensive operational studies, including manned simulations, have pitted EF2000 against potential opposition from expected upgrades of the MiG-29 Fulcrum and the SU-27 Flanker. The studies also included other modern combat aircraft. Whilst details of these studies must remain classified, the EF2000 performed favourably in both BVR and close combat situations.

One way of expressing the BVR capability is to look at an air combat effectiveness rating graph. This is calculated using information from the studies and uses the worst case scenario as an opponent, in this case an upgraded SU-27 Flanker. A score of 1 on the graph means that you would always win against the SU-27, while a score of 0 means you would always lose. A score of 0.5 indicates parity, or 50:50.

**BEYOND VISUAL RANGE COMBAT - 1 VERSUS 1**



BVR Combat Parameter Ratio Vs BVR Projected Threat

As you can see, the EF2000, with a score of 0.82 is well within the 'Always Win' sector and is bettered only by the U.S. F-22. It should be noted, however, that this aircraft is twice the cost of the EF2000 and does not have the air-to-surface capability of the EF2000.

One of the main reasons for the excellent performance of the EF2000 is that it can out-turn the SU-27 Flanker and its developments at both subsonic and supersonic speeds and it will also out-accelerate them. In fact, the EF2000 will accelerate and climb from runway alert to Mach 1.5 at above 35,000 feet in less than 2.5

minutes. At high altitude, carrying four medium range and two short range missiles, the aircraft will cruise above Mach 1 without the use of re-heat. At low level, in just 30 seconds, it can accelerate from 200 knots to Mach 1.

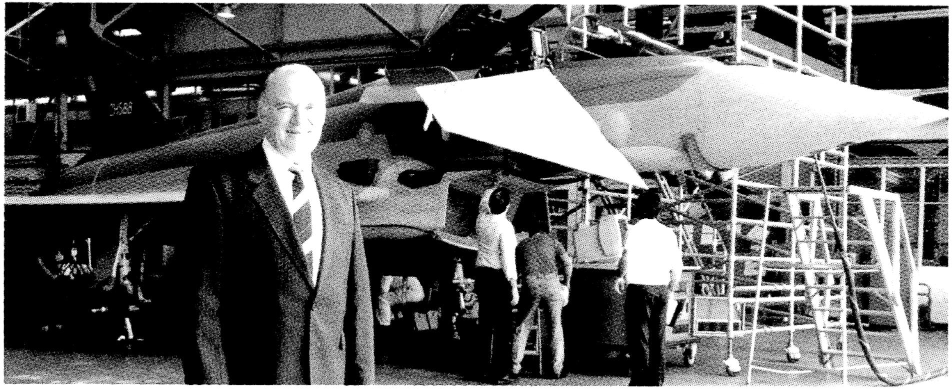
The new multi-role fighter's ferry capability of about 2,000 nautical miles, without mid air refuelling, will be a useful feature for world wide deployment. With dispersed operation in mind, the aircraft has an impressive short-field performance. For example, with the two Eurojet turbo-fan engines delivering just over 40,000lb of thrust, the take off distance with full internal fuel, gun, ammunition, four medium range and two short range missiles, is only about 300 metres, and the aircraft is airborne in less than seven seconds.

On Sunday 27 March 1994, on a bright day in Bavaria, Peter Weger, the chief test pilot of MBB, took off for the first flight of the prototype EF2000. This was an important milestone in the development of the aircraft. Subsequently there have been many flights of further prototypes and the EF2000 is now well on track for delivery to the RAF in the year 2000.

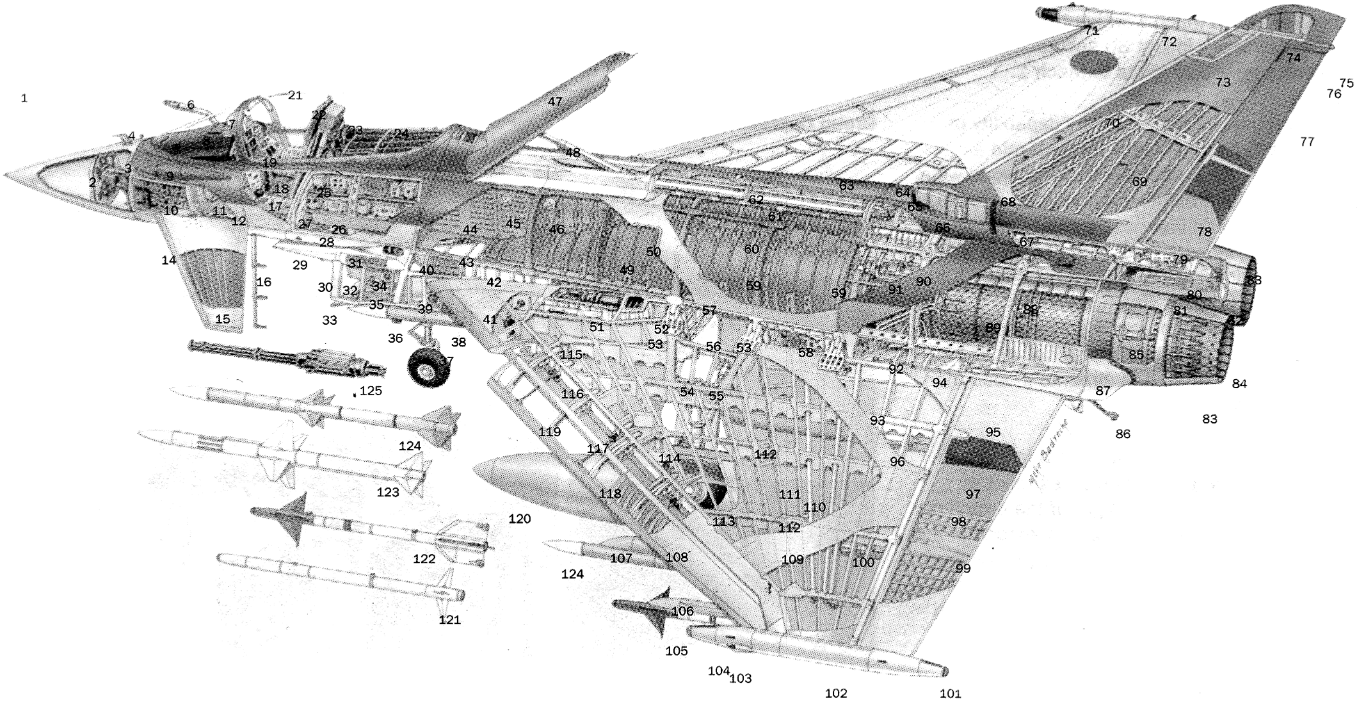
This aircraft represents a major development in aircraft technology and will provide the best air defence worldwide well into the 21st century.

I hope you enjoy flying it!"

**Group Captain Ned Frith**



# EUROFIGHTER 2000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# EUROFIGHTER 2000

1 Glass-reinforced plastic (GRFP) radome
2 GEC-marconi avionics ECR 90 multi-mode pulse doppler radar scanner
3 Scanner tracking mechanism
4 Pitot head
5 Temperature probe
6 Retractable flight refuelling probe
7 GEC-Marconi Avionics head-up display
8 Instrument panel shroud
9 Forward looking infra-red (FLIR)
10 Radar equipment module
11 Rudder pedals
12 Foreplane hydraulic actuator
13 Pivot bearing
14 Port canard foreplane
15 Foreplane diffusion bonded titanium structure
16 Retractable boarding steps
17 Side console panel with engine throttle levers
18 Control column, Bodenseewerk Geratetechnik quadruplex digital fly-by-wire system
19 Instrument panel with Smiths Industries full-colour head-down-displays
20 Rear view mirrors
21 Upward hinging cockpit canopy
22 Martin-Baker Mk 16A 'zero-zero ejector seat'
23 Cockpit pressurization valves
24 Canopy rear decking
25 Avionics equipment bay
26 Fuselage strake
27 Sloping cockpit rear pressure bulkhead
28 Air conditioning plant beneath avionics bay
29 Boundry layer splitter plate, bleed air perforations on lower surface
30 Port engine air intake
31 Bleed air spill louvres
32 Intake central divider
33 Variable capture area articulated intake lower lip
34 Canopy external release
35 Intake lip hydraulic actuators
36 Lower UHF antenna
37 Aft retracting nose undercarriage
38 Forward fuselage semi-recessed missile carriage
39 Pressure refuelling connection
40 Air conditioning system heat exchanger exhaust
41 Fixed inboard wing leading edge
42 Fuselage lower longeron
43 Intake trunking
44 Forward fuselage fuel tank, port and starboard
45 Gravity fuel fillers
46 Canopy hinge point
47 Dorsal airbrake
48 Airbrake hydraulic jack
49 Centre fuselage integral fuel tanks
50 Fuel tank access hatch
51 Auxiliary power unit (APU) cannon bay on starboard side
52 Ammo magazine, cross feed to starboard cannon
53 Titanium wing panel attachment fittings
54 Main undercarriage leg pivot mounting
55 Hydraulic retraction jack
56 Main undercarriage wheel bay
57 Carbon-fibre composite (CFC) centre fuselage skin
58 Secondary Power System (SPS) equipment bay, airframe mounted gearbox
59 Machined wing panel attachment main fuselage bulkheads
60 Fuselage upper longeron
61 Dorsal spine fairing air and cable ducting
62 Anti-corrosion strobe light
63 Starboard wing integral fuel tank
64 Wing tank fire suppressant foam filling
65 Heat exchanger ram air intake
66 Engine bleed air primary heat exchanger
67 Heat exchanger exhaust shield
68 Fin CFC skin panel
69 Aluminium-lithium (Al-li) 'sine-wave' fin spars
70 Al-li leading edge
71 Starboard navigation light
72 Wing tip active jamming pod
73 HF antenna
74 Upper UHF/IFF antenna
75 Tail navigation light
76 Fuel jettison
77 Rudder
78 Rudder honeycomb core
79 CFC skin panels
80 Rudder hydraulic actuator
81 Brake parachute stowage
82 Parachute door
83 Engine nozzle shroud panels
84 Variable area afterburner nozzle
85 Afterburner nozzle actuator (4)
86 Emergency arrester hook
87 Tailpipe sealing plates
88 Rear engine mounting
89 Eurojet EJ2000 afterburning low-bypass turbofan engine
90 Forward main engine mounting spigot
91 Fuel system piping
92 Engine accessory equipment
93 Port wing integral fuel tank
94 Rear missile housing
95 Port inboard elevon
96 Inboard elevon hydraulic actuator in ventral fairing
97 Elevon honeycomb core
98 CFC skin panels
99 Outboard elevon all-titianium structure
100 Outboard elevon hydraulic actuator in ventral fairing
101 Rear RWR antenna
102 Port wing tip active jamming pod
103 Ventral cooling air section
104 Port navigation light
105 Forward RWR antenna
106 Outboard missile pylon
107 Intermediate pylon
108 Port leading edge slats
109 Wing panel CFC skins
110 Cable conduits
111 Multi-spar aluminium alloy wing internal structure
112 Pylon mounting hardpoint
113 Port mainwheel
114 Leg door mounted landing/taxiing lamp
115 Inboard stores pylon mounting hardpoint
116 Front spar
117 Slat operating torque shaft and screw jacks, central hydraulic drive motor
118 Al-li slat rib structure
119 Slat guide rails
120 External fuel tank
121 BAe advanced Short-Range Air-to-Air Missile (ASRAAM)
122 AIM-9L Sidewinder air-to-air missile
123 BAe Sky Flash intermediate range air-to-air missile
124 AIM-120 AMRAAM, advanced medium range air-to-air missile
125 Mauser 27mm cannon, mounted in starboard wing root

# EF2000 INSTALLATION & SET-UP

## GETTING STARTED

### MINIMUM SYSTEM REQUIREMENTS

Computer: IBM, or fully compatible, 80486 DX2 66 MHz.
System Memory: 8 MB of RAM, with 5 MB EMS free.
Hard Drive: with at least 12 MB free.
Conventional Memory: at least 500 KB free.
Graphics: VESA compliant SVGA graphics card and SVGA colour monitor.
CD-ROM Drive: one single or double-speed
DOS: MS-DOS 5.0 or higher.

### RECOMMENDED SYSTEM SETUP

For best results with EF2000, you should have the following:
90 MHz or faster Pentium compatible processor.
16 MB RAM with EMS (expanded memory) manager.
MPC level 2 compatible CD-ROM drive with quad speed.
Hard drive with at least 5 MB free after installing the game files.
A fast VESA compliant SVGA graphics card with PCI or VESA local bus.
Joystick, CH FlightStick Pro, ThrustMaster Flight Control System (FCS or F-16), ThrustMaster Weapons Control System (WCS or TQS).
A Microsoft compatible mouse.
Sound Blaster AWE32 or Gravis Ultrasound.

### VESA GRAPHICS SET-UP

Some newer graphics cards are VESA SVGA compliant in hardware. However, the majority of cards require a driver to be installed first. To do this, find the installation software that was included with your computer system or graphics card, and locate the VESA driver. If you have no luck, updated drivers are often found on BBS. Alternatively, copy the file UNIVBE.EXE from the EF2000 CD-ROM to your root directory, and type UNIVBE at the C:\ prompt. Note the message printed on your screen. If all is well, it will have registered the chip-set of your card, and you should be able to run EF2000. If this fails, then contact the supplier or manufacturer of your graphics card for the correct driver, and notify Digital Image Design.

### MEMORY TIPS

EF2000 requires 500 KB of conventional memory, which may be a problem with some system set-ups. Please be aware that 500 KB is actually 512 KB (1 KB = 1,024 bytes). To check how much conventional memory you have free, type MEM/C at the DOS prompt. Memory allocation on IBM compatible PCs is a complex business, so please consult your DOS manual for advice.

### HOW TO WIN MORE MEMORY

The easiest way to get enough memory to run EF2000 is to create a boot disk and use it to start your computer when you want to play. When installing EF2000 you will be asked whether you want to make such a disk. Make sure that the CONFIG.SYS and AUTOEXEC.BAT files of the boot disk contain the drivers necessary to run your CD-ROM drive and your mouse.

Have a formatted 1.44 MB floppy disk ready if you want to make a boot disk. In addition, check your CONFIG.SYS file to ensure that it has the

# EF2000 INSTALLATION & SET-UP

## GETTING STARTED

DOS=HIGH command. This is very important, as DOS cannot be loaded high without it. If you have Terminate-and-Stay-Resident (TSR) programs - such as mouse drivers, network drivers, DOS shells and RAM disks - make sure they are loaded into high memory with the DEVICEHIGH (in CONFIG.SYS) or LOADHIGH (in AUTOEXEC.BAT) commands. Consult your DOS or expanded memory manager manual for precise details. Some TSRs will not load into high memory. Make a boot disk which excludes these TSR programmes.

**WARNING. BEFORE CHANGING YOUR CONFIG.SYS OR AUTOEXEC.BAT FILES, (SYSTEM FILES) ALWAYS COPY THEM TO A BOOTABLE FLOPPY DISK! IF ANYTHING GOES WRONG, BOOT YOUR COMPUTER WITH THIS DISK AND COPY THE SYSTEM FILES BACK TO THE HARD DISK, REPLACING THE FAULTY SYSTEM FILES.**

The EMM386 memory manager included with MS-DOS 5.0 or 6.0 should be adequate. If not, try using a commercial EMS manager such as the type supplied with QEMM by Quarterdeck. Third-party EMS managers often use less conventional memory and improve your ability to load TSRs into high memory. Commercial EMS managers can also provide you with additional expanded memory without modifying your CONFIG.SYS file. However we cannot accept responsibility for any problems encountered with such third party memory managers.

If you have DOS 6.0 or higher, use the memory optimizer called MemMaker. Simply type MEMMAKER and press Enter at the DOS prompt. MEMMAKER will alter your CONFIG.SYS and AUTOEXEC.BAT files to make your setup more memory efficient. MEMMAKER will try to load as much into high memory as possible. It will not remove TSRs that cannot be loaded high. If, after running MEMMAKER, you still don't have enough conventional memory free, you should edit your CONFIG.SYS and AUTOEXEC.BAT files to avoid TSRs that cannot load high (type REM before the line which loads the TSR). Refer to the DOS 6.0 manual for more details on MEMMAKER and editing system files.

### TO INSTALL EF2000

NOTE: EF2000 requires that several files be installed on your hard disk.

1. Place the CD-ROM in the CD-ROM drive.
2. Make sure that the CD-ROM drive is the current drive. (Type the letter of that drive usually D: or E:, followed by a colon, then press ENTER.)
3. Type the word 'INSTALL' and press ENTER.
4. Follow the on-screen instructions.
5. We recommend you run the built-in diagnostics routines to check that your hardware is fully compatible with the software.
6. We also recommend that you calibrate your joystick.
7. Making a boot disk is always a good idea too, as this can help resolve any hardware/software conflicts quickly.
8. Once the installation and set-up routines are complete, the game is ready to play. Switch to the hard disk where your EF2000 directory is installed, and type 'EF2000'.

### CONFIGURATION AFTER INSTALLATION

To change hardware configuration after running the install program, change to the EF2000 directory and type 'CONFIG'. A screen appears that allows you to modify the entire set-up. Once you have made changes, be sure to press the 'SAVE' button before returning to DOS.

# EF2000 CONTROLLERS

## SETTING-UP YOUR PREFERRED INTERFACE

### KEYBOARD

The cursor control arrows may be used to control the EF2000's direction of flight. This may be a convenient option for portable computers, but we strongly recommend a joystick for flight control. See 'Key Summary' for an overview of all key controls.

ARROW KEYS: Pitch up, pitch down, left and right.

### MOUSE

The installation program auto-detects the presence of a mouse driver, and utilizes the driver if found. EF2000 supports Microsoft compatible mouse drivers. A mouse is necessary for selecting various control options during the game.

**N.B. A mouse cannot be used for controlling aircraft movement.**

LEFT-BUTTON: Select/deselect function.
RIGHT-BUTTON: Equivalent to the ESC key.

### SINGLE JOYSTICK

A joystick provides a higher degree of control compare with the keyboard. This option is activated by selecting 'One Joystick' when editing the EF2000 CONFIG file, or when in the SET-UP screen.

JOYSTICK MOVEMENT: back to pitch up, forward to pitch down, left and right for sideways motion.
BUTTON 1: Fires the selected weapon.
BUTTON 2: Toggles selected weapons.

### JOYSTICK WITH THROTTLE

The joystick and two buttons function in the same manner as in the 'One Joystick option'. This joystick has an extra control in the form of a throttle wheel or lever, which controls the EF2000 engine power. The throttle device takes precedence over the keyboard throttle, which is disabled.

JOYSTICK MOVEMENT: Back to pitch up, forward to pitch down, left and right for side movement.

BUTTON 1: Fires the selected weapon.
BUTTON 2: Toggles selected weapons.
THROTTLE WHEEL: Adjusts the EF2000 throttle.

### THRUSTMASTER FLIGHT CONTROL SYSTEM

EF2000 supports the ThrustMaster Flight Control System, which consists of a standard pistol-grip type flight stick, a four position hat controller, and four buttons. The flight stick portion of the Flight Control System functions in the same manner as a standard joystick.

The hat is used to control simulation points-of-view. When you are in the pilot's cockpit, the hat is used to control your in-board point-of-view. All of the corresponding keyboard controls remain active.

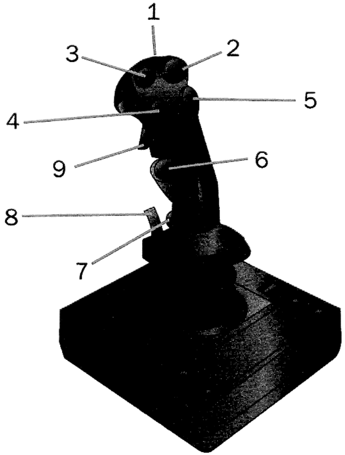
JOYSTICK MOVEMENT: Back to pitch up, forward to pitch down, left and right for side movement.

# EF2000 CONTROLLERS

## SETTING-UP YOUR PREFERRED INTERFACE

### THRUSTMASTER F-16 FLIGHT CONTROL SYSTEM

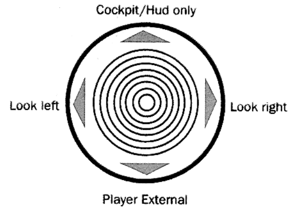
This is the latest Flight Control System from ThrustMaster, modelled on the real F-16 stick. It also closely resembles the centrally positioned joystick of the EuroFighter, and is therefore a good choice for use with EF2000.



NOTE. All ThrustMaster configurations are suggestions only.

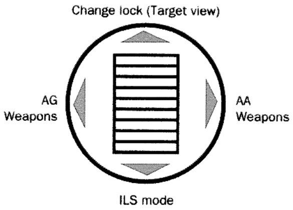
1 Afterburners On/Off

2.

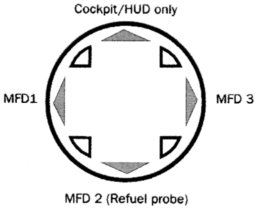

Cockpit/Hud only
Look left
Look right
Player External

3. Virtual track On/Off

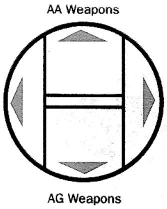
4.


Change lock (Target view)
AG Weapons
AA Weapons
ILS mode

5.


Cockpit/HUD only
MFD1
MFD 3
MFD 2 (Refuel probe)

6.

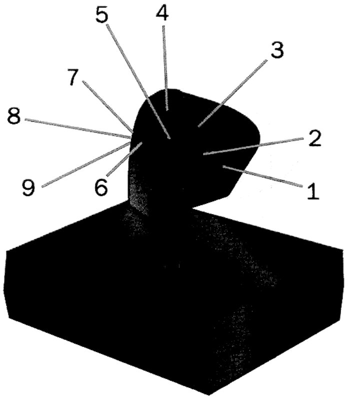

AA Weapons
AG Weapons

7. Pinky button – commands in brackets.
8. Hi-res/Lo-res
9. Release weapon

## SETTING-UP YOUR PREFERRED INTERFACE

### THRUSTMASTER WEAPON CONTROL SYSTEM

The ThrustMaster Weapon Control System replaces many keyboard functions with a convenient one-handed controller. It includes a throttle lever, six push buttons, and one rocker switch. There is no set-up choice for the WCS in the configuration file or SET-UP screen; it is activated by attaching it to your computer and keyboard. To activate, follow the installation instructions included with the unit. The Weapon Control System is a keyboard emulator that simply duplicates the entry of certain keys. Setting specific dip switches to the "on" position configures the WCS unit for EF2000. See addendum - THRUSTMASTER CONFIG FILES.



1. Map toggle
2. Chaff
3. Flares
4. Engine start left
5. Engine start right
6. Gear up/down

Rocker positions;

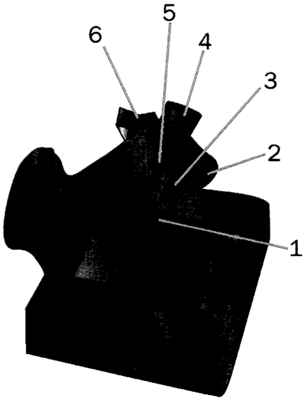
7. Rocker up: Wheel brakes
8. Rocker middle: N/A
9. Rocker down: Airbrakes

# EF2000 CONTROLLERS

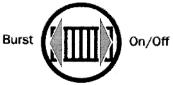
## SETTING-UP YOUR PREFERRED INTERFACE

### THRUSTMASTER THROTTLE QUADRANT SYSTEM

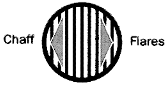
This is the latest throttle system from ThrustMaster. It features a thumb-trackball, which is ideal for use with the EF2000 in-cockpit graphical user-interface (mouse controlled MFDs).



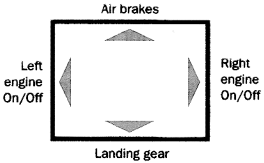
1. Trackball
2. N/A
3. Afterburner


Burst
On/Off

4. N/A
5. Defences


Chaff
Flares

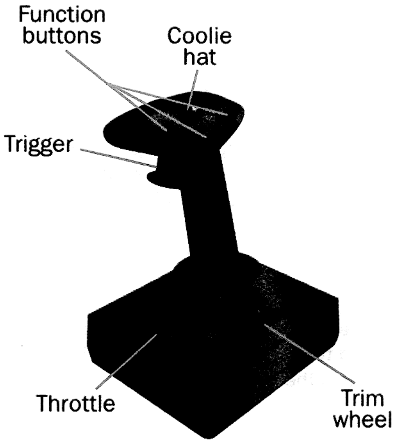
6. General


Air brakes
Left engine On/Off
Right engine On/Off
Landing gear

### CH FLIGHTSTICK PRO

This is an excellent and affordable joystick which is highly recommended for use with EF2000. It has a coolie hat, several buttons and a built-in throttle

**JOYSTICK MOVEMENT:** Back to pitch up, forward to pitch down, left and right for side movement.
**BUTTON 1:** Fires the selected weapon.
**BUTTON 2:** Select weapon
**BUTTON 3:** Cycles targets in radar, HUD and Padlock view.
**THROTTLE WHEEL:** Adjusts the EF2000 throttle
**COOLIE HAT:** Activates various views


Function buttons
Coolie hat
Trigger
Throttle
Trim wheel

# EF2000 QUICK START

## HOW TO USE THIS HANDBOOK

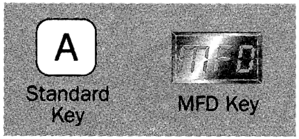
### GETTING STARTED FAST

This manual starts by giving a few tips on how to get in the air fast. However, we hope that you will eventually take the time to read this handbook, and understand some of the amazing concepts that are going into a new generation of fighter aircraft like EF2000. Every section has been thoroughly researched, and it's not just a book of how to work the game. It has been written to give you a better understanding of why planes like EF2000 are built, and why they are built the way they are.

### SOME GENERAL HINTS

Writing a manual to cater for everyone is no easy task. Some people want plenty of background information, others want the relevant gameplay facts, and a few simply want the key guide. We have tried to keep everyone happy, by writing for every type of player.

NOTE: in the sections covering key commands, there are two types of keys shown: standard keyboard types and Multi-Function Display keys from within the game.



If you can't wait to get airborne, we suggest that you go to the simulator and select free flight. This will give you a chance to explore the beautiful scenery that stretches over four million square kilometres. The next section contains a few tips on how to get in the air fast.

If you have any ideas or additions that you feel would be useful for EF2000 pilots, please send them to: The EF2000 Project Manager, Digital Image Design, Tannery Court, Tanners Lane, Warrington, Cheshire, WA2 7NR, England

# EF2000 QUICK START

## SO YOU WANT TO FLY NOW?

If you can't wait to get airborne, go to 'Quick Combat'. Alternatively, for a little sightseeing in the four million square kilometre world, go to 'Simulator' and select the 'Free-flight' and choose a location. Refer to the 'Quick Key' guide to get started.

- Experiment with the control method you have chosen. If you are not sure whether this is set correctly, select the appropriate controller from the set-up menu.
- Experiment with the throttle settings (+ and - keys, or other controller if fitted)
- Experiment with AG weapons by pressing 'backspace' to make new selections.
- Experiment with AA weapons by pressing 'ENTER' to make new selections
- SPACEBAR or the joystick releases weapons, unless they are the type that needs a target lock-on.
- Press 'B' to extend the airbrake and see what happens. Don't slow down too much, however.
- Fly around, try a few rolls and loops, just to get the feel.
- If you lose too much airspeed, activate the reheat (afterburner) by pressing the ✱ key. Turn off the reheat by pressing '/'.

# EF2000 QUICK START

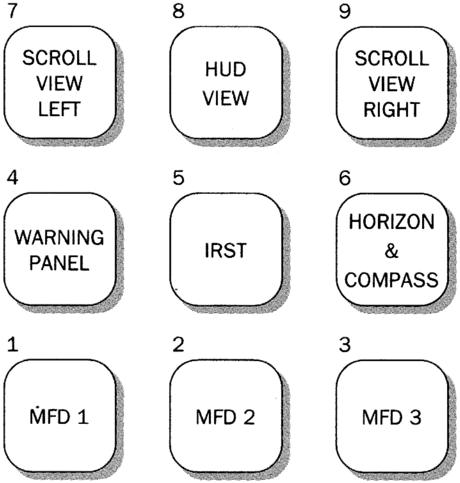
## QUICK CONTROL FAMILIARISATION

If you can't wait to fly before discovering all the amazing EF2000 systems, here's a quick key guide to get you airborne and down again with the minimum of fuss.

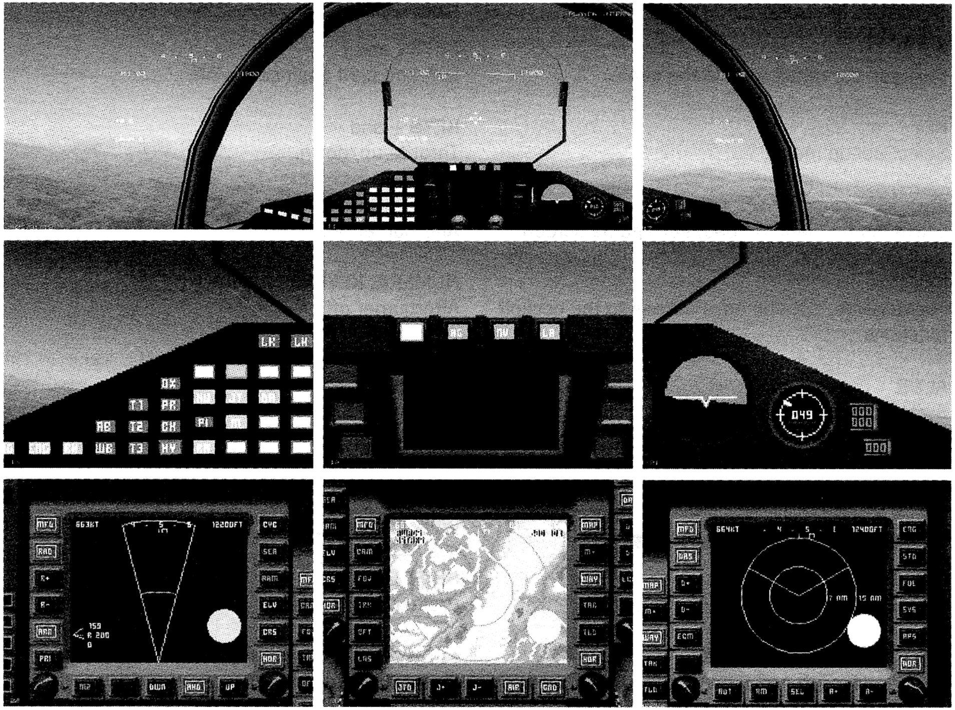
| | |
|---|---|
| [ ] | **Engines ON/OFF** |
| + - | **Throttle UP/DOWN** |
| B | **Airbrake ON/OFF** |
| * / | **After burner ON/OFF** |
| W | **Wheelbrake ON/OFF** |
| Shift + Esc | **Ejection** |

| | |
|---|---|
| Space 1 | **Fire weapon** |
| Enter | **Select AA weapon** |
| ← | **Select AG weapon** |
| P | **Pause** |
| G | **Landing Gear UP/DOWN** |
| Shift Q | **Quit** |
| Shift S | **Skip to next event** |

# THE EASY-VIEW GUIDE


7
SCROLL VIEW LEFT
8
HUD VIEW
9
SCROLL VIEW RIGHT
4
WARNING PANEL
5
IRST
6
HORIZON & COMPASS
1
MFD 1
2
MFD 2
3
MFD 3

Each of the nine numeric keys represents a key view in EF2000



# EF2000 KEYS

## KEY SUMMARY

### GENERAL IN-GAME CONTROLS

ALT D
Changes the detail level in the game.

KEY `
Select set-up menu.

ESC
Leave set-up menu or load/save game screen.

KEY P
Pause game, but still have access to the cockpit functions.

ALT R
Switch resolutions in game.

SHIFT C
Cycle browse plane views.

### GENERAL AIRCRAFT CONTROLS

KEY G
Retracts or lowers the landing gear.

KEY < OR >
Move rudder left and right (in the air).

### ENGINES

KEYS [ and ]
Left and right engines on/off.

KEYS + and -
Throttle up/down.

NUMERIC KEYPAD *
Afterburner on.

NUMERIC KEYPAD/
Afterburner off.

### BRAKES

KEY B
Airbrake on/off.

KEY W
Wheelbrake on/off.

SHIFT B
Brake chute deployed.

ALT B
Brake chute jettisoned.

KEY < OR >
Activate nose-wheel steering (on the ground).

### WINGMEN

NUMBERS 1-9
Select or execute wingmen menu/command.

TAB
Select or close wingmen menu/command

# EF2000 KEYS

## KEY SUMMARY

KEY Y
Confirm ability to execute an order or request.

KEY N
Confirm inability to execute an order or request.

### MFD AND SYSTEM VIEWS

NUMERIC KEY 0
Select mission briefing summary.

NUMERIC KEY .
Select large map. Press ESC to exit.

NUMERIC KEY 1
Select MFD 1.

NUMERIC KEY 2
Select MFD 2.

NUMERIC KEY 3
Select MFD 3.

NUMERIC KEY 4
Select warning panel.

NUMERIC KEY 5
Select IRST screen.

NUMERIC KEY 6
Select artificial horizon and compass.

NUMERIC KEY 7
Scroll left in 60 degree steps.

NUMERIC KEY 8
Select full HUD view.

NUMERIC KEY 9
Scroll right in 60 degree steps.

MOUSE BUTTONS
Pan down to MFDs.

RIGHT MOUSE BUTTON
Return to head-up view.

DRAG MOUSE TO SCREEN EDGE
Moves the view around the cockpit.

CTRL & LETTER
Select the MFD functions by using a combination of CTRL and letters instead of the mouse.

### MFD SYSTEMS

KEY C
Cycle prioritised targets during BVR combat. (also cycles short range targets during close combat mode).

KEY D
Select DASS.

KEY E
Activate jamming or ECM.

# EF2000 KEYS

## KEY SUMMARY

KEY J
Select JTIDS.

KEY M
Moving Map.

KEY R
Select radar.

SHIFT W
Select next waypoint.

ALT W
Select previous waypoint.

### HUD KEYS

KEY U
Cycle HUD contrast.

ALT H
Cycle HUD declutter.

SHIFT '
Refuelling HUD mode.

ENTER
AA HUD mode.

BACKSPACE
AG HUD mode.

KEY I
Landing HUD mode.

### EVENT KEYS

SHIFT T
Accelerated time for the whole environment.

KEY P
Pause game, while still having access to cockpit functions.

SHIFT S
Skip to next event of interest. NOTE: skips to point prior to refuelling and landing, or completes these events if pressed again. Does not work if a threat is near by. Also cancels Time Skip.

SHIFT ESC
Eject.

SHIFT Q
Quit EF2000 to DOS.

### WEAPON KEYS

ENTER
Scroll through the AA weapons.

BACKSPACE
Scroll through the AG weapons.

SPACEBAR
Fire weapons (also depends on controller type).

SHIFT J
Jettison fuel tanks.

ALT J
Jettison air-to-ground stores.

KEY C
Cycles through targets.

# EF2000 KEYS

## KEY SUMMARY

### TIALD LASER BOMBING KEYS

KEY T
Select TIALD laser-guided bombing sight.

RIGHT SHIFT CURSOR
Slew IR or TV image.

SPACEBAR OR JOYSTICK BUTTON 1
Release weapon.

### SET-UP KEYS

KEY `
Access the SET-UP screen.

ESC OR RIGHT MOUSE BUTTON
Leave SET-UP.

### AUTOPILOT & FLIGHT ASSISTANCE KEYS

KEY A
Activate/deactivate autopilot.

ALT A ONCE
Select Autopilot mode 1 waypoint.

ALT A TWICE
Select Autopilot mode 2 heading, altitude & speed.

ALT A 3 TIMES
Select Autopilot mode 3 tracking.

ALT A 4 TIMES
Select Autopilot mode 4 autothrottle.

KEY L
Auto leveller.

MFD +/-
Adjust speed in Autopilot mode 4.

KEY C
Cycle track in Autopilot mode 3.

SHIFT W
Select next waypoint in Autopilot mode 1.

ALT W
Select previous waypoint in Autopilot mode 1.

KEY V
Activate Night Vision (NV).

### OTHER KEYS

INSERT
Release chaff manually.

DELETE
Release flares manually.

KEY ´
Deploy refuelling nozzle, enter refuelling mode.

SHIFT ´
Switch to refuelling HUD mode.

KEY I
ILS mode for landing.

# EF2000 VIEWS

## VIEW SUMMARY

### MAIN COCKPIT VIEWS

KEY F1
Cycles between the cockpit and HUD view and the HUD only view.

SHIFT A
Overlays DASS and radar in HUD only view.

NUMERIC KEY 8
Restore the full forward cockpit view.

### MFD VR COCKPIT VIEW

SHIFT F1
Full cockpit view with MFDs.

### WIDE ANGLE VR COCKPIT

KEY F2
Wide angle cockpit for dogfighting.

### CHECK YOUR SIX

KEY F3
Executes a rear looking check on the sky.

GLANCE LEFT NUMERIC KEY 7
Pan left in sixty degree steps.

GLANCE RIGHT NUMERIC KEY 9
Pan right in sixty degree steps.

### PLAYER EXTERNAL VIEWS

KEY F4
Toggles between a standard external view, and several pre-set camera views.

SHIFT F4
A satellite or God's eye view of the world.

### WINGMAN VIEWS

KEY F5
Cycles between a full wingman view, wingman and player, player and wingman, and a wingman's cockpit view.

SHIFT C
Cycles between wingmen.

### FLY-BY VIEWS

KEY F6
Your fly-by, or you and nearest missile.

SHIFT F6
Selected target fly-by or, if no target selected, browse plane.

### TARGET VIEWS

KEY F7
Cycles between a full target view, target and player, player and target, and a view of the target and his target.

### WEAPONS VIEWS

KEY F8
Cycles between a full external view of the missile and a weapon's eye view.

### VR PADLOCK

KEY F10
Padlocks you onto any enemy plane or missile within sight. Press again to padlock enemy missiles.

### LOOK AT MFDs

NUMERIC 1
View MFD 1.

NUMERIC 2
View MFD 2.

NUMERIC 3
View MFD 3.

# EF2000 VIEWS

## VIEW SUMMARY

### LOOK AT OTHER COCKPIT PANELS

NUMERIC 4
View warning panel.

NUMERIC 5
View IRST.

NUMERIC 6
View artificial horizon and compass.

### MANUAL SCROLLING VIEWS

SHIFT PLUS CURSORS
Scroll around the cockpit or external view.

### EXTERNAL VIEW ZOOM

SHIFT PLUS NUMERIC 7 OR 1
Zoom external views.

### HUD ON AND OFF

ALT H
Declutter HUD view.

### TOGGLE TARGET VIEW MODE

KEY C
Cycle selected track.

TAB
Select or close wingmen menu/command mode).

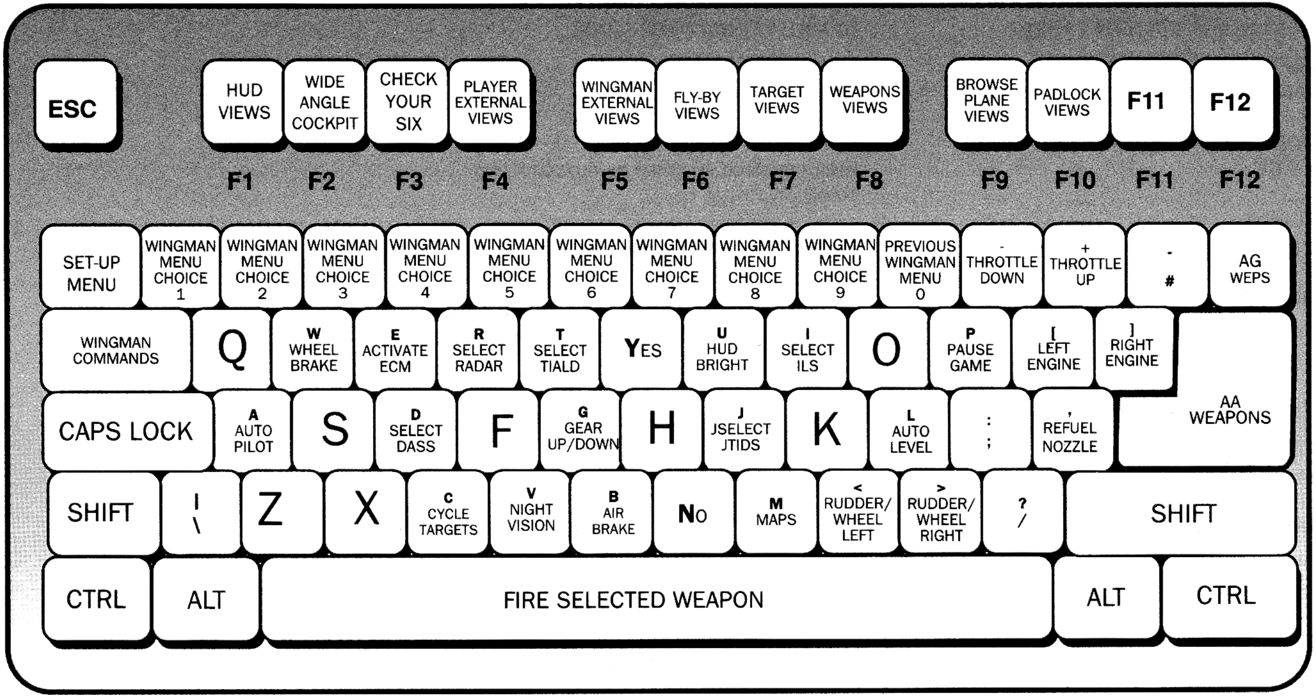
### BROWSE PLANE VIEWS

F9
External of any aeroplane, the selected plane and the player, and the selected plane and its target.

SHIFT C
Cycle browse plane (any plane within 50 nm).

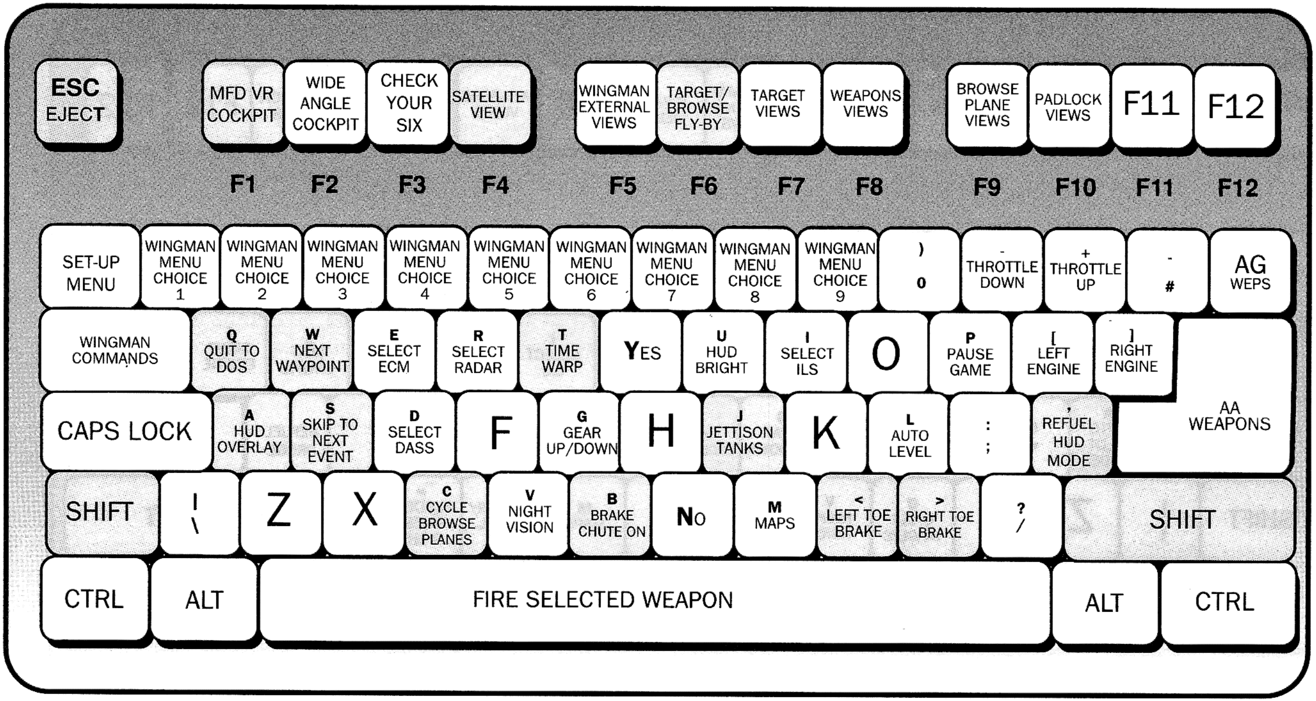
# EF2000 KEYS & VIEWS

## UNSHIFTED KEYBOARD


ESC
HUD VIEWS
WIDE ANGLE COCKPIT
CHECK YOUR SIX
PLAYER EXTERNAL VIEWS
WINGMAN EXTERNAL VIEWS
FLY-BY VIEWS
TARGET VIEWS
WEAPONS VIEWS
BROWSE PLANE VIEWS
PADLOCK VIEWS
F11
F12
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
SET-UP MENU
WINGMAN MENU CHOICE 1
WINGMAN MENU CHOICE 2
WINGMAN MENU CHOICE 3
WINGMAN MENU CHOICE 4
WINGMAN MENU CHOICE 5
WINGMAN MENU CHOICE 6
WINGMAN MENU CHOICE 7
WINGMAN MENU CHOICE 8
WINGMAN MENU CHOICE 9
PREVIOUS WINGMAN MENU 0
- THROTTLE DOWN
+ THROTTLE UP
- #
AG WEPS
WINGMAN COMMANDS
Q
W WHEEL BRAKE
E ACTIVATE ECM
R SELECT RADAR
T SELECT TIALD
YES
U HUD BRIGHT
I SELECT ILS
O
P PAUSE GAME
[ LEFT ENGINE
] RIGHT ENGINE
AA WEAPONS
CAPS LOCK
A AUTO PILOT
S
D SELECT DASS
F
G GEAR UP/DOWN
H
J JSELECT JTIDS
K
L AUTO LEVEL
: ;
, REFUEL NOZZLE
SHIFT
| \
Z
X
C CYCLE TARGETS
V NIGHT VISION
B AIR BRAKE
NO
M MAPS
< RUDDER/ WHEEL LEFT
> RUDDER/ WHEEL RIGHT
? /
SHIFT
CTRL
ALT
FIRE SELECTED WEAPON
ALT
CTRL

# EF2000 KEYS & VIEWS

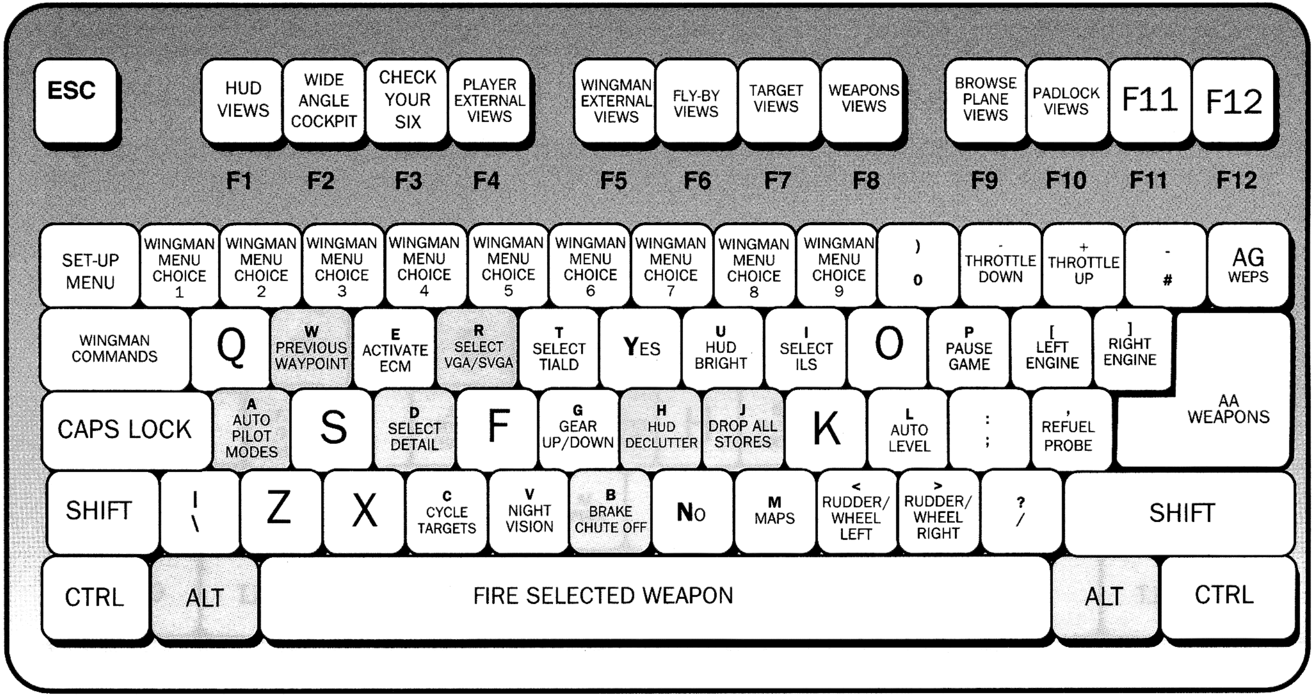
## SHIFTED KEYBOARD



ESC EJECT
MFD VR COCKPIT
WIDE ANGLE COCKPIT
CHECK YOUR SIX
SATELLITE VIEW
WINGMAN EXTERNAL VIEWS
TARGET/ BROWSE FLY-BY
TARGET VIEWS
WEAPONS VIEWS
BROWSE PLANE VIEWS
PADLOCK VIEWS
F11
F12
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
SET-UP MENU
WINGMAN MENU CHOICE 1
WINGMAN MENU CHOICE 2
WINGMAN MENU CHOICE 3
WINGMAN MENU CHOICE 4
WINGMAN MENU CHOICE 5
WINGMAN MENU CHOICE 6
WINGMAN MENU CHOICE 7
WINGMAN MENU CHOICE 8
WINGMAN MENU CHOICE 9
) 0
- THROTTLE DOWN
+ THROTTLE UP
- #
AG WEPS
WINGMAN COMMANDS
Q QUIT TO DOS
W NEXT WAYPOINT
E SELECT ECM
R SELECT RADAR
T TIME WARP
YES
U HUD BRIGHT
I SELECT ILS
O
P PAUSE GAME
[ LEFT ENGINE
] RIGHT ENGINE
AA WEAPONS
CAPS LOCK
A HUD OVERLAY
S SKIP TO NEXT EVENT
D SELECT DASS
F
G GEAR UP/DOWN
H
J JETTISON TANKS
K
L AUTO LEVEL
: ;
, REFUEL HUD MODE
SHIFT
| \
Z
X
C CYCLE BROWSE PLANES
V NIGHT VISION
B BRAKE CHUTE ON
NO
M MAPS
< LEFT TOE BRAKE
> RIGHT TOE BRAKE
? /
SHIFT
CTRL
ALT
FIRE SELECTED WEAPON
ALT
CTRL

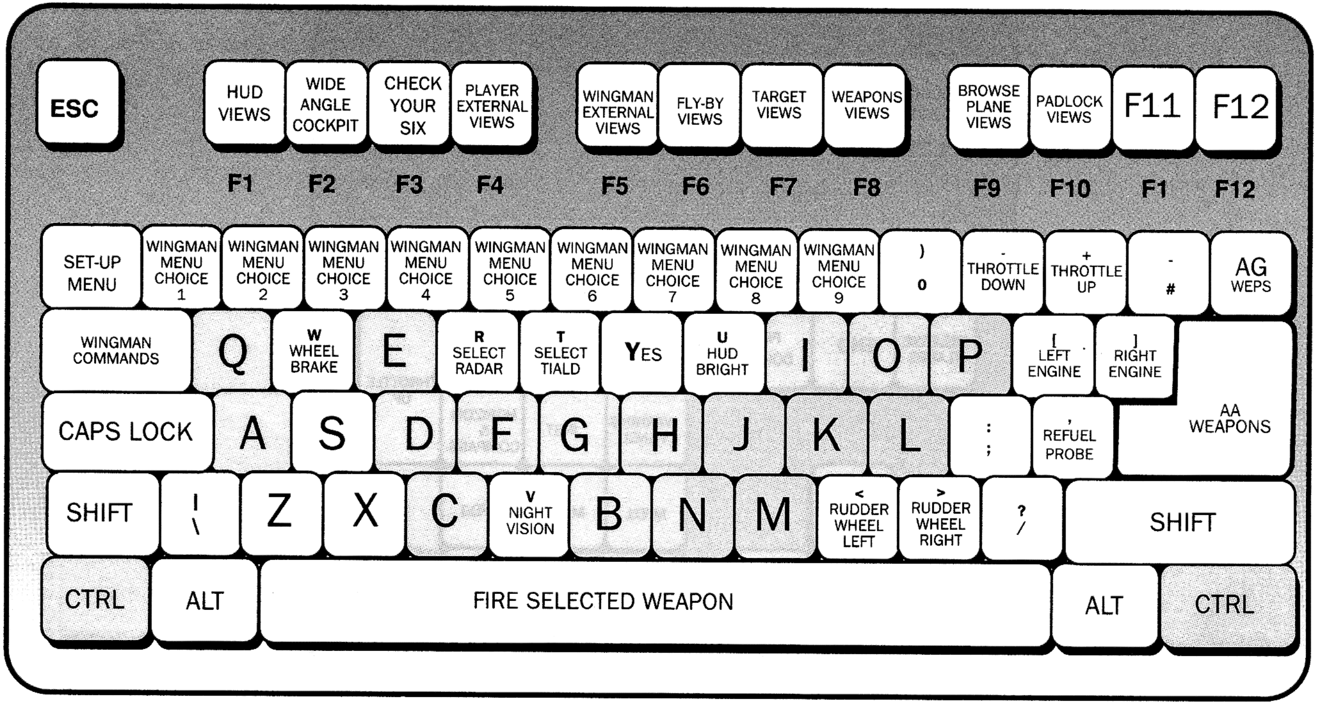
# EF2000 KEYS & VIEWS

## ALT KEYBOARD


ESC
HUD VIEWS
WIDE ANGLE COCKPIT
CHECK YOUR SIX
PLAYER EXTERNAL VIEWS
WINGMAN EXTERNAL VIEWS
FLY-BY VIEWS
TARGET VIEWS
WEAPONS VIEWS
BROWSE PLANE VIEWS
PADLOCK VIEWS
F11
F12
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
SET-UP MENU
WINGMAN MENU CHOICE 1
WINGMAN MENU CHOICE 2
WINGMAN MENU CHOICE 3
WINGMAN MENU CHOICE 4
WINGMAN MENU CHOICE 5
WINGMAN MENU CHOICE 6
WINGMAN MENU CHOICE 7
WINGMAN MENU CHOICE 8
WINGMAN MENU CHOICE 9
) 0
- THROTTLE DOWN
+ THROTTLE UP
- #
AG WEPS
WINGMAN COMMANDS
Q
W PREVIOUS WAYPOINT
E ACTIVATE ECM
R SELECT VGA/SVGA
T SELECT TIALD
YES
U HUD BRIGHT
I SELECT ILS
O
P PAUSE GAME
[ LEFT ENGINE
] RIGHT ENGINE
AA WEAPONS
CAPS LOCK
A AUTO PILOT MODES
S
D SELECT DETAIL
F
G GEAR UP/DOWN
H HUD DECLUTTER
J DROP ALL STORES
K
L AUTO LEVEL
: ;
, REFUEL PROBE
SHIFT
| \
Z
X
C CYCLE TARGETS
V NIGHT VISION
B BRAKE CHUTE OFF
NO
M MAPS
< RUDDER/ WHEEL LEFT
> RUDDER/ WHEEL RIGHT
? /
SHIFT
CTRL
ALT
FIRE SELECTED WEAPON
ALT
CTRL

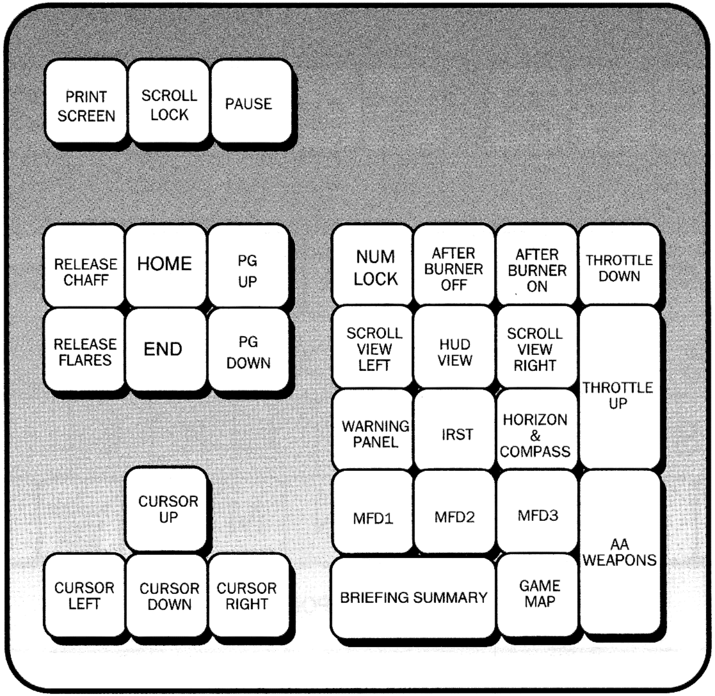
# EF2000 KEYS & VIEWS

## KEYBOARD MFD CONTROLS WITH CTRL


ESC
HUD VIEWS
WIDE ANGLE COCKPIT
CHECK YOUR SIX
PLAYER EXTERNAL VIEWS
WINGMAN EXTERNAL VIEWS
FLY-BY VIEWS
TARGET VIEWS
WEAPONS VIEWS
BROWSE PLANE VIEWS
PADLOCK VIEWS
F11
F12
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F1
F12
SET-UP MENU
WINGMAN MENU CHOICE 1
WINGMAN MENU CHOICE 2
WINGMAN MENU CHOICE 3
WINGMAN MENU CHOICE 4
WINGMAN MENU CHOICE 5
WINGMAN MENU CHOICE 6
WINGMAN MENU CHOICE 7
WINGMAN MENU CHOICE 8
WINGMAN MENU CHOICE 9
) 0
- THROTTLE DOWN
+ THROTTLE UP
- #
AG WEPS
WINGMAN COMMANDS
Q
W WHEEL BRAKE
E
R SELECT RADAR
T SELECT TIALD
YES
U HUD BRIGHT
I
O
P
[ LEFT ENGINE
] RIGHT ENGINE
AA WEAPONS
CAPS LOCK
A
S
D
F
G
H
J
K
L
: ;
, REFUEL PROBE
SHIFT
| \
Z
X
C
V NIGHT VISION
B
N
M
< RUDDER WHEEL LEFT
> RUDDER WHEEL RIGHT
? /
SHIFT
CTRL
ALT
FIRE SELECTED WEAPON
ALT
CTRL

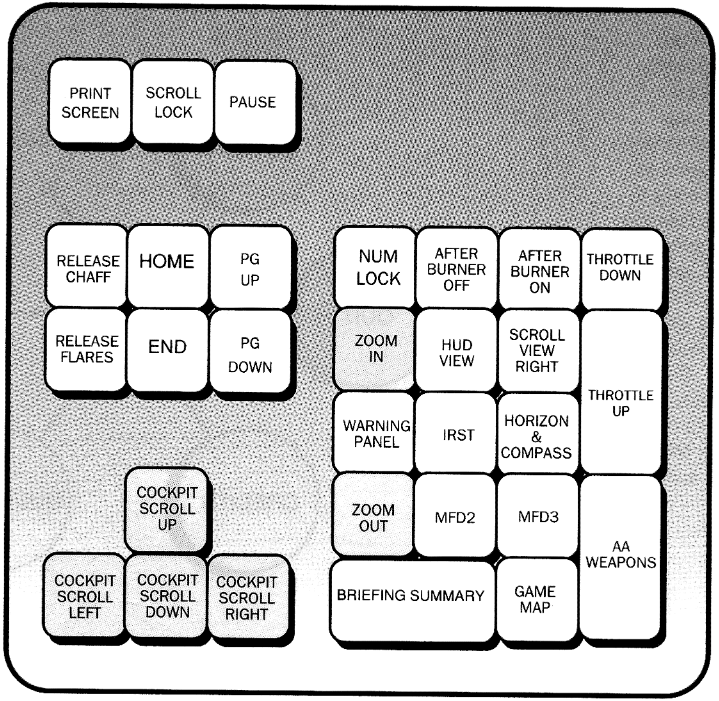
# EF2000 KEYS & VIEWS

## EXTENDED KEYBOARD UNSHIFTED


PRINT SCREEN
SCROLL LOCK
PAUSE
RELEASE CHAFF
HOME
PG UP
RELEASE FLARES
END
PG DOWN
CURSOR UP
CURSOR LEFT
CURSOR DOWN
CURSOR RIGHT
NUM LOCK
AFTER BURNER OFF
AFTER BURNER ON
THROTTLE DOWN
SCROLL VIEW LEFT
HUD VIEW
SCROLL VIEW RIGHT
THROTTLE UP
WARNING PANEL
IRST
HORIZON & COMPASS
MFD1
MFD2
MFD3
AA WEAPONS
BRIEFING SUMMARY
GAME MAP

# EF2000 KEYS & VIEWS

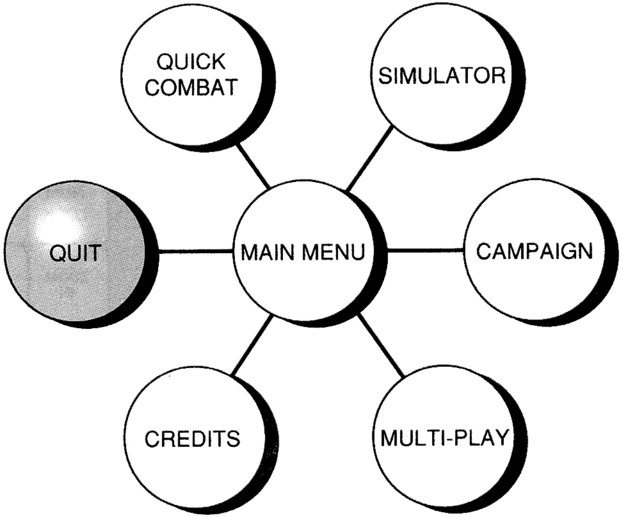
## EXTENDED KEYBOARD SHIFTED


PRINT SCREEN
SCROLL LOCK
PAUSE
RELEASE CHAFF
HOME
PG UP
RELEASE FLARES
END
PG DOWN
COCKPIT SCROLL UP
COCKPIT SCROLL LEFT
COCKPIT SCROLL DOWN
COCKPIT SCROLL RIGHT
NUM LOCK
AFTER BURNER OFF
AFTER BURNER ON
THROTTLE DOWN
ZOOM IN
HUD VIEW
SCROLL VIEW RIGHT
THROTTLE UP
WARNING PANEL
IRST
HORIZON & COMPASS
ZOOM OUT
MFD2
MFD3
AA WEAPONS
BRIEFING SUMMARY
GAME MAP

# EF2000 OVERVIEW

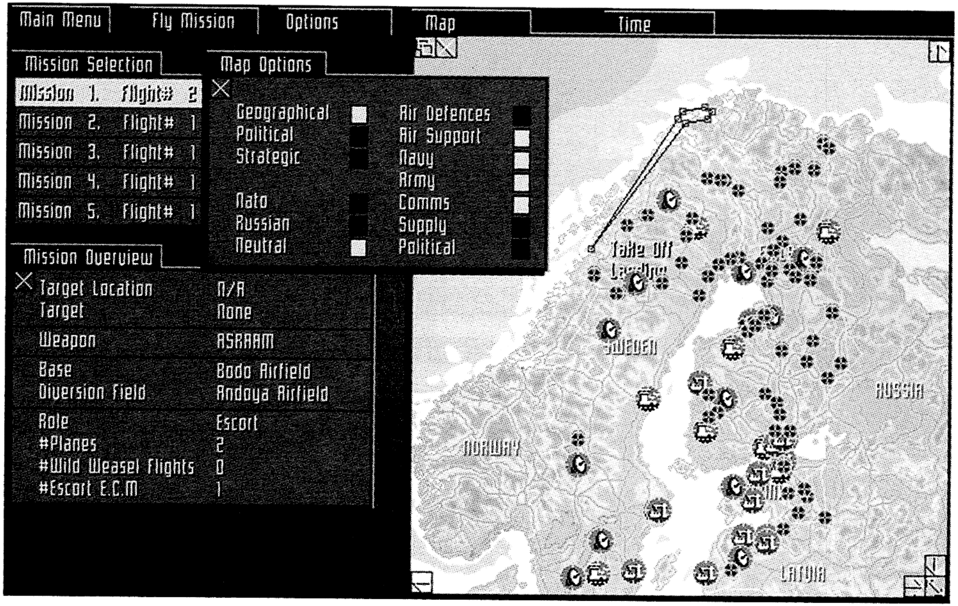
## FINDING YOUR WAY AROUND EF2000

This diagram shows the major modules in EF2000. When you enter the program for the first time, you'll go straight to the configuration screen. Here you will be able to set up vital hardware and software parameters. See the Technical Notes for tips on settings for different types of PC systems. Next, you will be taken to the 'MAIN MENU. From here, you can choose to enter one of several modules: the Quick Combat section, which is a fast and furious shooting spectacle; the simulator, where you will practise all the manoeuvres you will need to play EF2000 effectively; the campaign section, where you will take part in a massive air/land battle; Multiplay, which allows you to join network games. Quit will take you back to DOS. When you enter any of the modules, it's always possible to return to the main menu simply by pressing the MAIN MENU button in the top left-hand corner of the screen.



# EF2000 GETTING STARTED

## THE DID DESKTOP


Main Menu
Fly Mission
Options
Map
Time
Mission Selection
Mission 1. Flight# 2
Mission 2. Flight# 1
Mission 3. Flight# 1
Mission 4. Flight# 1
Mission 5. Flight# 1
Map Options
Mission Overview
Take Off
Landing
SWEDEN
NORWAY
RUSSIA
LATVIA

Geographical ☑
Political ☐
Strategic ☐
Nato ☐
Russian ☐
Neutral ☑
Air Defences ☐
Air Support ☑
Navy ☑
Army ☑
Comms ☑
Supply ☐
Political ☐

| | |
|---|---|
| Target Location | N/A |
| Target | None |
| Weapon | ASRAAM |
| Base | Bodo Airfield |
| Diversion Field | Andoya Airfield |
| Role | Escort |
| #Planes | 2 |
| #Wild Weasel Flights | 0 |
| #Escort E.C.M | 1 |

The DID desktop

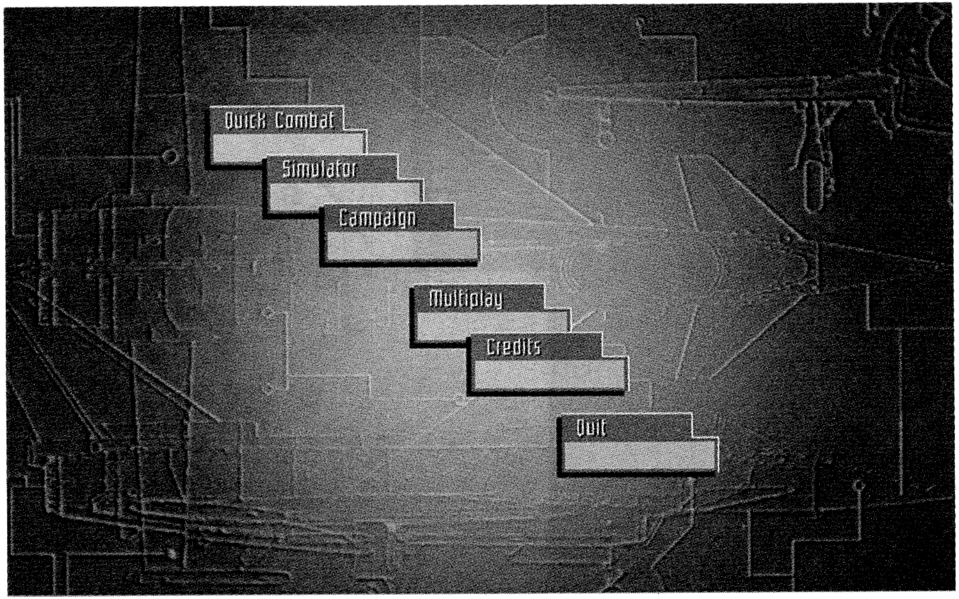
A new feature for DID products is a desktop style interface with menu folders, to help expert and beginner alike navigate the many features of EF2000. We have tried to make it as intuitive as possible, and ensure every aspect of the programme is easily accessible.

A variety of icons are available in the interface to control the functionality of the menus. The small X in the top left hand corner will close the menu. In some cases, it is possible to overlay windows in order to see more information or make comparisons. A small icon of overlaid pages enables you to bring the current window to the front or send it to the back of the display. On scrolling windows, arrow icons are available on the right and bottom of the screen. On resizable windows, a small arrow in the bottom right corner will allow you to expand or shrink the window. A special icon in the top right hand corner will expand the window full-screen.

# EF2000 GETTING STARTED

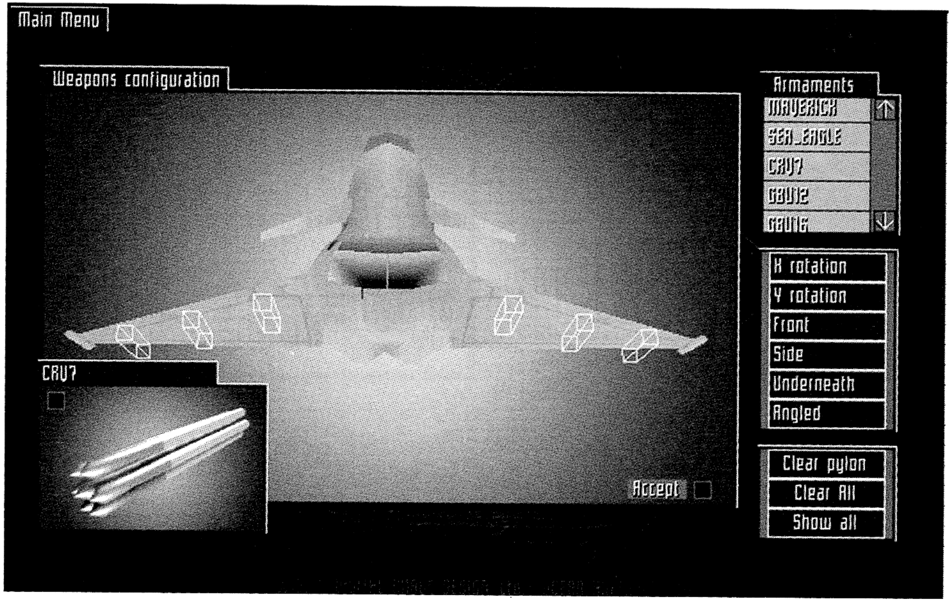
## MAIN MENU

From here you may enter any module of the software. Press QUIT if you wish to leave EF2000. While using the interface, you can always return here if you wish to retire to DOS.


Quick Combat
Simulator
Campaign
Multiplay
Credits
Quit

The main menu

## WEAPONS ARMING


Main Menu
Weapons configuration
Armaments
MAVERICK
SEA_EAGLE
CRV7
GBU12
GBU16
X rotation
Y rotation
Front
Side
Underneath
Angled
Clear pylon
Clear All
Show all
CRV7
Accept

The arming screen

In this screen, you will be allowed to review the default weapons load, and re-arm the plane. The process is straightforward. . .

1. From the top right-hand window, select your desired weapon. An image of the chosen bomb or missile will be visible in a window.

2. Move your cursor into the main arming screen, and the chosen weapon will be placed by the cursor.

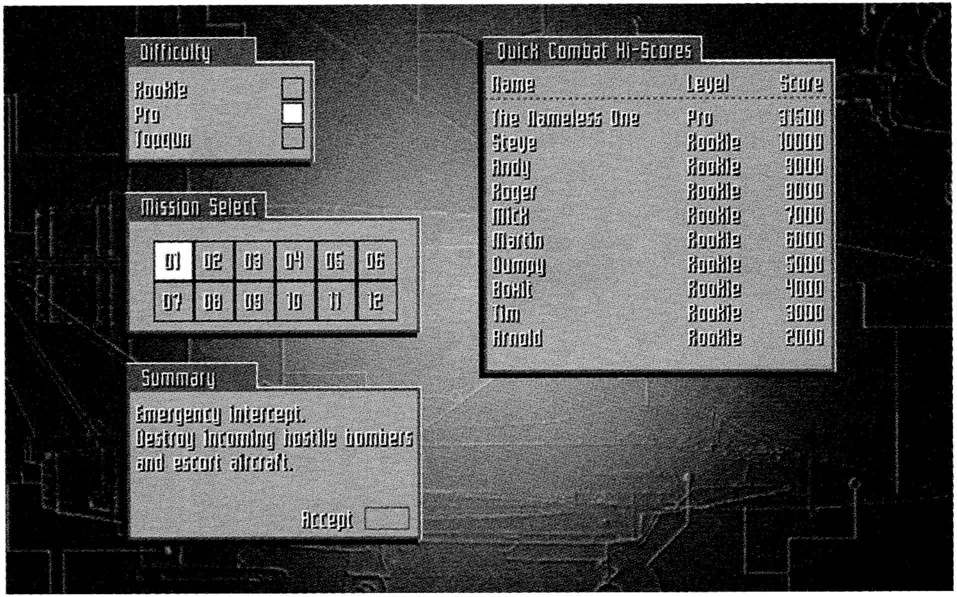
3. Place the weapon on the pylon by simply positioning the cursor over the green box and click the left mouse button. Red boxes indicate that the weapon may not be placed on that pylon. Note that you need only arm one side of the plane, and weapons are automatically placed symmetrically.

4. If you would like to view the plane from various angles, click on the view keys.

## QUICK COMBAT

Quick Combat is a section of the simulation designed to drop you right into the action, with the kind of weird and wonderful missions that are only possible in a simulation. It's there for fun, and to help you chill out after a hard day by letting you blast hell out of everything and anything. Pressing Quick Combat on the main menu will bring you to the selection screen. From here, you may set the difficulty level for the missions, which will affect the quantity and quality of the air and ground based threats. You may elect to start at mission 1 and progress to mission 12, or jump in wherever you like. A brief summary of what will happen will be given, and on the map you will be able to see where the mission will take place.

If you do well, you will enter the next level automatically. If you lose and you have a high score, you will get the opportunity to enter your name in the high score table. If you do not have a high enough score, you will simply be returned to the Quick Combat menu.



Rookie ☐
Pro ☑
Topgun ☐

Emergency Intercept.
Destroy Incoming hostile bombers and escort aircraft.

Quick Combat Hi-Scores

| Name | Level | Score |
|---|---|---|
| The Nameless One | Pro | 31500 |
| Steve | Rookie | 10000 |
| Andy | Rookie | 9000 |
| Roger | Rookie | 8000 |
| Mick | Rookie | 7000 |
| Martin | Rookie | 6000 |
| Dumpy | Rookie | 5000 |
| Boxit | Rookie | 4000 |
| Tim | Rookie | 3000 |
| Arnold | Rookie | 2000 |

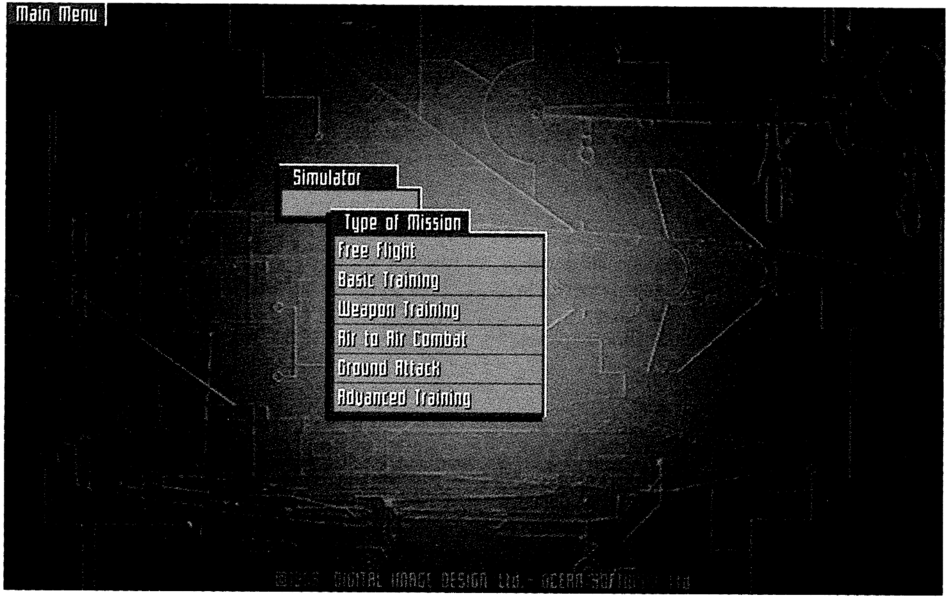
The Quick Combat menu

## SIMULATOR

The simulator section has been designed to let you practise the skills you need to be a top EF2000 pilot. The missions are specially designed, and give you a taste of the many faceted gameplay in EF2000. Time spent in the simulator is time well spent when you decide to enter a campaign.

Your first choice is the mission type. This produces a sub-menu showing the ground-school curriculum. Choose an item from this menu and you will be presented with another list containing specific missions. Choose a mission and you will activate the briefing window. Read this carefully to decide what is required.

Now is your first chance to decline the mission, or accept if you want to try it out. After pressing 'accept', you will see the 'parameters' menu, which allows you to adjust the way the mission looks and plays. Work down the list, activating the desired check boxes. Before accepting, decide whether you want the default weapons, and whether you want to see the weapons set-up.



The simulator menu

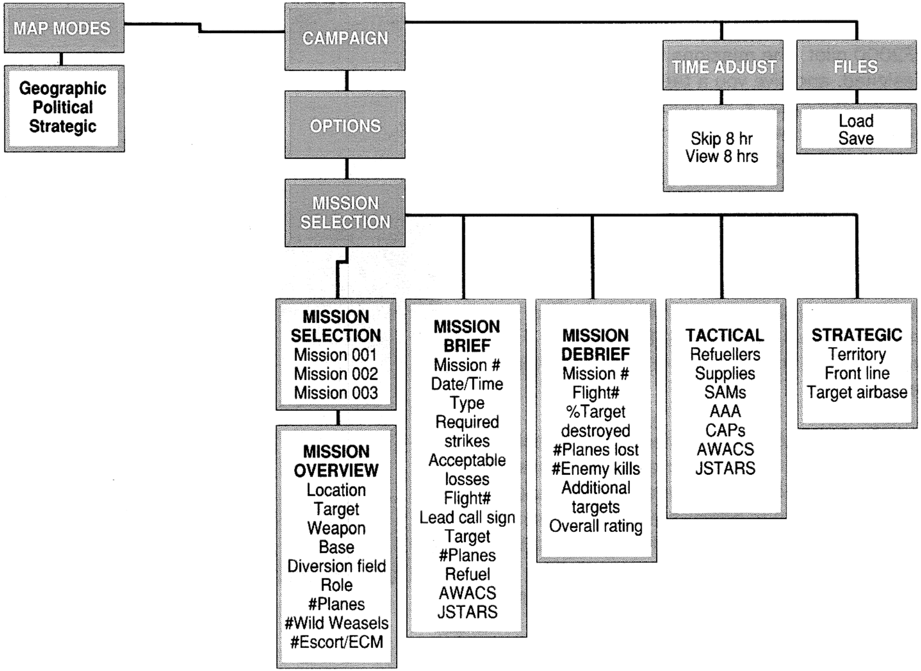
After accepting  mission and deciding to review the weapons, you will be taken to the arming screen. Here you will be able to adjust your weapons load, and review available missiles and bombs. Finally, press the accept key to begin the mission.

# EF2000 GETTING STARTED

## CAMPAIGN

In campaign, you are joining a complex simulation of a war environment. You therefore have access to a great deal of information about your flight, your forces and the enemy. The entire campaign is managed by a non-linear Artificial Intelligence system which operates using modern doctrine on aerial warfare. For a complete description, turn to the campaign section of this manual.

The moment you choose 'Campaign' from the main menu, a combat environment is set-up in the world. You then enter the campaign interface, with various menus at your disposal.


MAP MODES
Geographic
Political
Strategic
CAMPAIGN
OPTIONS
MISSION SELECTION
TIME ADJUST
Skip 8 hr
View 8 hrs
FILES
Load
Save
MISSION SELECTION
Mission 001
Mission 002
Mission 003
MISSION OVERVIEW
Location
Target
Weapon
Base
Diversion field
Role
#Planes
#Wild Weasels
#Escort/ECM
MISSION BRIEF
Mission #
Date/Time
Type
Required strikes
Acceptable losses
Flight#
Lead call sign
Target
#Planes
Refuel
AWACS
JSTARS
MISSION DEBRIEF
Mission #
Flight#
%Target destroyed
#Planes lost
#Enemy kills
Additional targets
Overall rating
TACTICAL
Refuellers
Supplies
SAMs
AAA
CAPs
AWACS
JSTARS
STRATEGIC
Territory
Front line
Target airbase

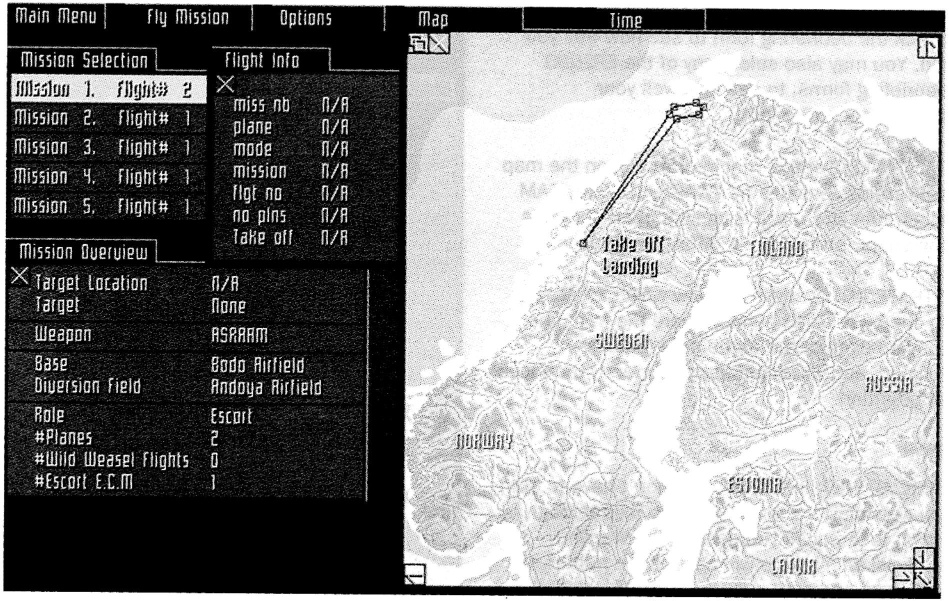
Campaign menus

## MISSION SELECTION

MISSION SELECTION: You can choose to fly any of the EF2000 missions generated in EF2000. Simply scroll through the choices given in the top window and click. You will notice the information in the mission overview changing accordingly. When you find the mission you wish to fly, press accept.

MISSION BRIEFING: If you would like more information about your mission, select this option. It will also tell you whether AWACS, JSTARS and refuellers are available, which in turn affects your ability to access JTIDS data, and your ability to engage in fuel intensive combat such as dogfighting.

TARGET VIEW: Select this menu, and you will be able to view your target in three different ways. Area view shows a satellite picture covering about 3 square miles. Zoom view shows the target in a square of less than a quarter mile. Target view shows a 3D image of the specified target, rotating 360 degrees to let you assess the various approach angles.


Main Menu
Fly Mission
Options
Map
Time
Mission Selection
Flight Info
Mission Overview
Take Off
Landing
FINLAND
SWEDEN
RUSSIA
NORWAY
ESTONIA
LATVIA

Mission 1. Flight# 2
Mission 2. Flight# 1
Mission 3. Flight# 1
Mission 4. Flight# 1
Mission 5. Flight# 1

| | |
|---|---|
| miss nb | N/A |
| plane | N/A |
| mode | N/A |
| mission | N/A |
| flgt no | N/A |
| no plns | N/A |
| Take off | N/A |

| | |
|---|---|
| Target Location | N/A |
| Target | None |
| Weapon | ASRAAM |
| Base | Bodo Airfield |
| Diversion Field | Andoya Airfield |
| Role | Escort |
| #Planes | 2 |
| #Wild Weasel Flights | 0 |
| #Escort E.C.M | 1 |

The mission selection menu

## MISSION SELECTION

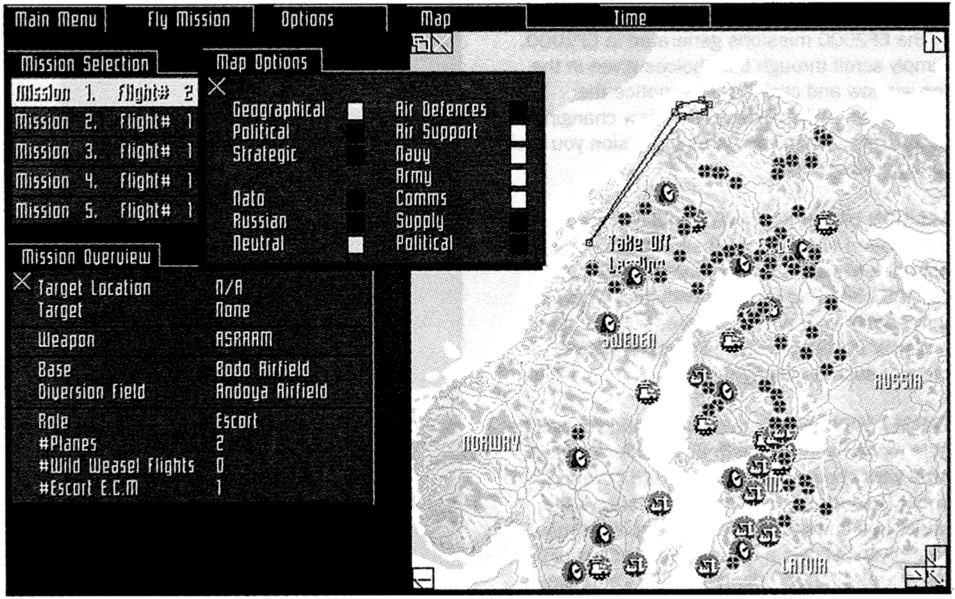
MISSION DEBRIEF: After flying your mission, check the debriefing form to see how well you did. You may also select any of the EF2000 debriefing forms, to see how well your colleagues performed.

TACTICAL: Overlays vital information on the map concerning coverage by AWACS, JSTARS, SAM sites, AAA sites, and refuellers. Also shown is the supply status at the different airbases.

STRATEGIC: Overlays to show which territory is in enemy or allied hands, where the front line or forward edge of the battle area (FEBA) is located, and which airbase is currently the focus of attention.

### TIME

TIME ADJUST: In EF2000 you don't have to start your campaign at the beginning. Skip through by days, to the point you desire. The WarGen artificial intelligence will fight all the battles in-between, and set up the world correctly for the given time. Use this feature with caution if you don't want to lose the war! There is a possibility to return by eight hours, but the results will be unpredictable due to the non-linearity of the system.



Mission Selection

Mission 1. Flight# 2
Mission 2. Flight# 1
Mission 3. Flight# 1
Mission 4. Flight# 1
Mission 5. Flight# 1

Map Options

| | | | |
|---|---|---|---|
| Geographical | ☑ | Air Defences | ☐ |
| Political | ☐ | Air Support | ☑ |
| Strategic | ☐ | Navy | ☑ |
| | | Army | ☑ |
| Nato | ☐ | Comms | ☑ |
| Russian | ☐ | Supply | ☐ |
| Neutral | ☑ | Political | ☐ |

Mission Overview

| | |
|---|---|
| Target Location | N/A |
| Target | None |
| Weapon | ASRAAM |
| Base | Bodo Airfield |
| Diversion Field | Andoya Airfield |
| Role | Escort |
| #Planes | 2 |
| #Wild Weasel Flights | 0 |
| #Escort E.C.M | 1 |

Campaign overview

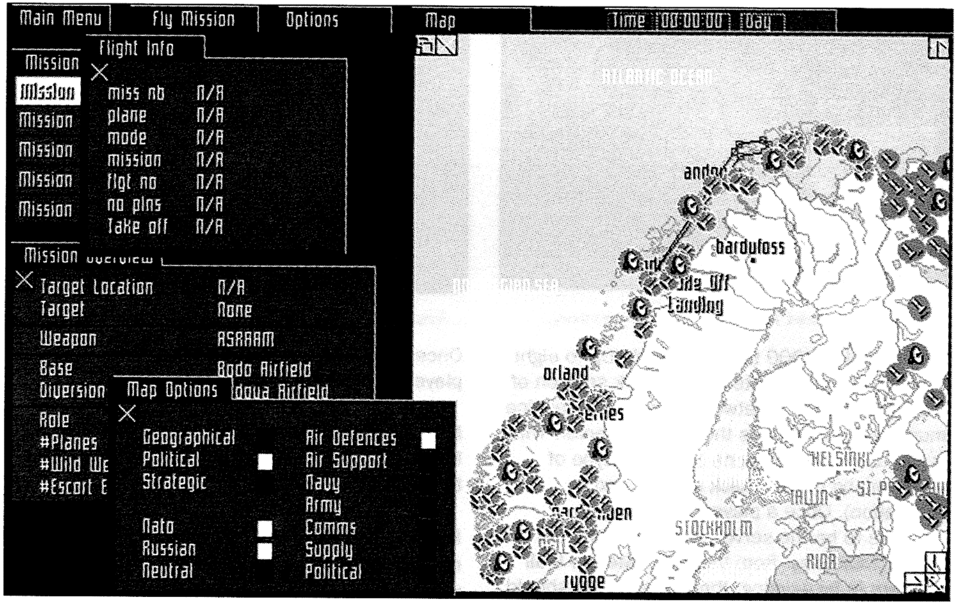
## MISSION SELECTION

### FILES

Save the campaign at the current time, or load a previously saved campaign. Note: you cannot save the mission during play. Either finish the mission, abort it or end it. In the latter case, the AI will predict the outcome of your mission for you.

### MAPS

MAP MODE: Gives you access to three types of map. Geographic gives the general topography of the region. Political shows the disposition of territories and shows major towns and cities. Strategic is a composite map of electronic intelligence from JSTARS and satellite images, and shows major vehicle movements within the world. Tactical and strategic information from the Options menu will be overlaid on these maps.


Main Menu
Fly Mission
Options
Map
Time 00:00:00 Day
Mission
Mission
Mission
Mission
Mission
Mission
Flight Info
Mission Overview
Map Options
Atlantic Ocean
andoy
bardufoss
Landing
orland
rygge
Helsinki
Stockholm
Tallin
Riga

Flight Info

| | |
|---|---|
| miss nb | N/A |
| plane | N/A |
| mode | N/A |
| mission | N/A |
| flgt no | N/A |
| no plns | N/A |
| Take off | N/A |

Mission Overview

| | |
|---|---|
| Target Location | N/A |
| Target | None |
| Weapon | ASRAAM |
| Base | Bodo Airfield |
| Diversion | ...doya Airfield |
| Role | |
| #Planes | |
| #Wild We... | |
| #Escort E... | |

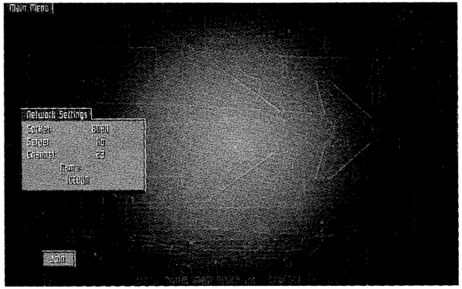
Map Options

| | | | |
|---|---|---|---|
| Geographical | | Air Defences | ☑ |
| Political | ☑ | Air Support | |
| Strategic | | Navy | |
| | | Army | |
| Nato | ☑ | Comms | |
| Russian | ☑ | Supply | |
| Neutral | | Political | |

Map mode

# EF2000 GETTING STARTED

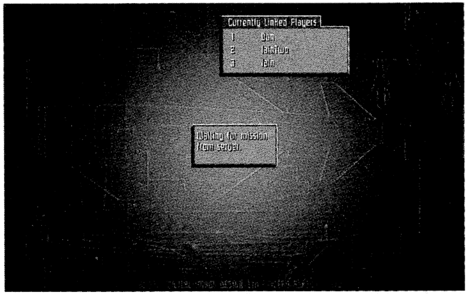
## MULTI-PLAYER



Socket 8080
Server No
Channel 23
Name:

One player must register as the server...

First install EF2000 to the network. Up to eight players may participate in a network session of EF2000. To start a network game, one machine must be nominated as the EF2000 server. This is where all the decisions about the type of game will be made (Quick combat and simulation). Once a player has chosen a machine to be the server, that player should select 'Multi-play' from the 'Main Menu'. If all appears to be working, the server player should press the 'Listen for players' button. The satellite players should now select the 'Multi-play' menu and press the 'join' button.



1 Dan
2 IainTwo
3 Iain

Waiting for mission from server.

...And the other players simply join in!

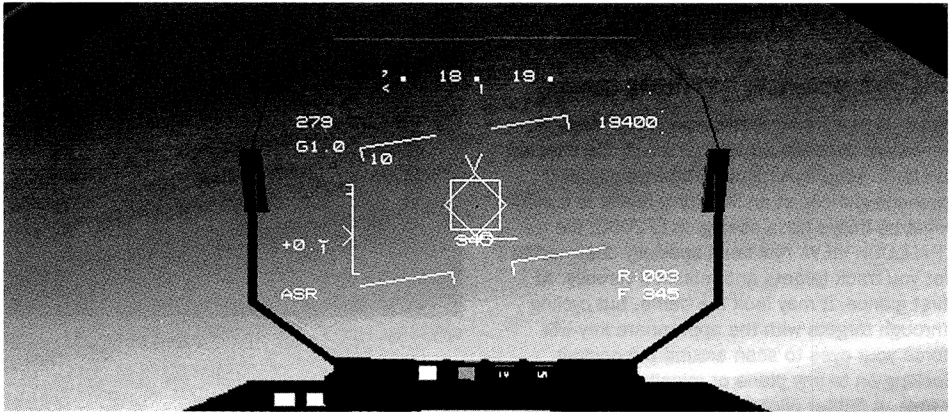
Once communications are established, the player lists will contain the valid players.

Now the server player should go to the 'Main Menu' and select the module and mission for the network session.

For the most recent information on EF2000 network play, check the file NETPLAY.TXT on your EF2000 CD-ROM.

# EF2000 VIEWS

## AN INTRODUCTION TO THE VIEWS



EF2000 creates a visual impression of flight without using complex multi-window views. The key to this experience is 'the virtual cockpit' overlaid with an advanced 'helmet mounted display' (HMD). Together, they help to create a 3D 'virtual environment' that is fully compatible with a new generation of 'virtual reality' headsets now becoming available.

EF2000 abandons the conventional approach to PC simulator cockpits, which place all the instruments and head-up display in a fixed-forward view. Instead, we chose to look through the pilot's eyes, and create a three-dimensional virtual cockpit which works just like the real thing. All it takes is a few simple keystrokes to navigate around the cockpit, but to get the most out of the avionics you'll need to understand a few basic concepts about using 'head-down and head-up' displays in modern air combat.

### INTERNAL VIEWS

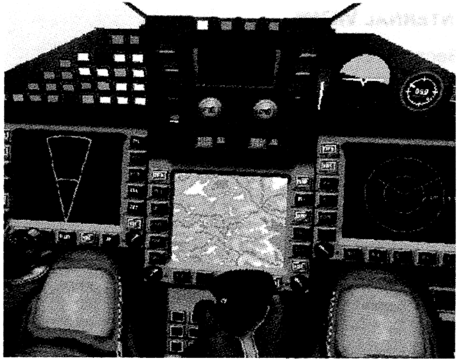
Because EF2000 features a true 3D cockpit, a wide range of exciting internal views are available. Special views have also been developed for use in combat, to enhance realism.

### EXTERNAL VIEWS

EF2000 has many cinematic viewing possibilities, to let you enjoy the action from a totally different perspective. Experiment with them in different situations, and soon you'll learn how external views can help improve your scores. For example, if you lose sight of your adversary during a dogfight, switch to the 'TARGET AND YOU' view to see where he is in relation to you. Or just select 'FLY-BY' to enjoy the view as you fly low over your airfield. You can even see what each side is up to as it prepares for war.

# EF2000 VIEWS

## EF2000 VIEWS IN USE


The advanced 'glass cockpit' (Shift F1)

### 'BEYOND VISUAL RANGE' (BVR) COMBAT

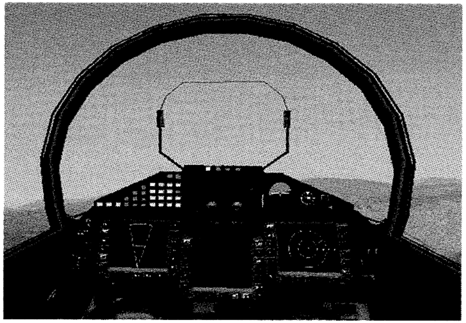
In a real fighter plane, where the pilot looks in the cockpit is totally dependent upon the changing air situation. For example, when using radar to initiate 'Beyond Visual Range' (BVR) combat at ranges above 100 nautical miles, the pilot has his head down in the cockpit to study radar or JTIDS pictures on the 'multi-function displays' (MFD's). He will glance-up occasionally, just to keep his eye on the outside environment and orientate himself. At long-ranges, the only way to track targets and launch BVR weapons is to monitor the displays.

### THE 'PADLOCK VIEW' FOR CLOSE COMBAT

When an adversary comes into visual range, at anywhere between 30 and 20 miles, the pilot will prefer to keep looking out of the canopy, and perhaps glances at an MFD only briefly to confirm what he thinks he is seeing. In EF2000, the 'PADLOCK VIEW' has been specially designed to let you track targets and missiles visually. At first glance, it may look the same, but cycling through targets with the appropriate key will force your eyes to scan around the cockpit, locking on to any plane or missile within visual range. A fighter pilot watches his enemy in the same way, never forgetting the motto 'lose sight, lose the fight'. 'PADLOCK VIEW' also works with ground targets.

### THE WIDE-ANGLE COCKPIT

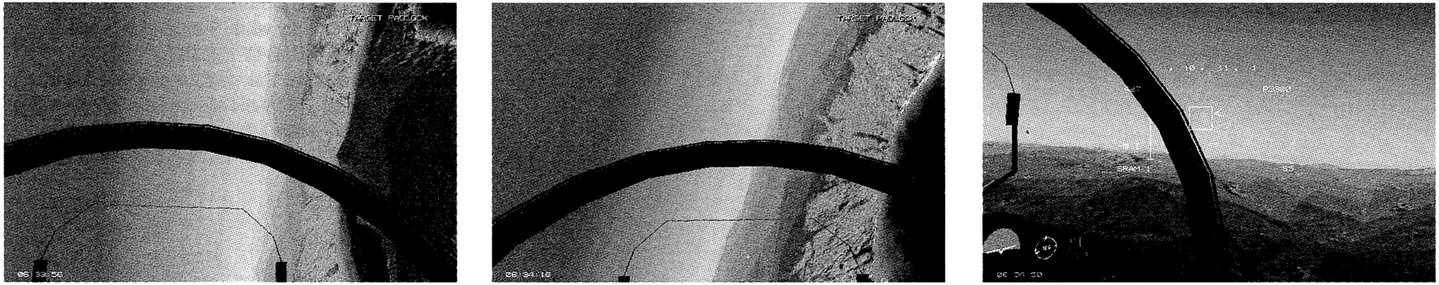
In a dogfight, you need a wide field-of-view to track the enemy. In the real aircraft, you are able to glance easily around the sky, but in the confines of a PC screen, it's not so easy. The wide-angle view helps a lot. Try it!


The wide-angle cockpit view (F2)

# EF2000 VIEWS

## EF2000 VIEWS IN USE

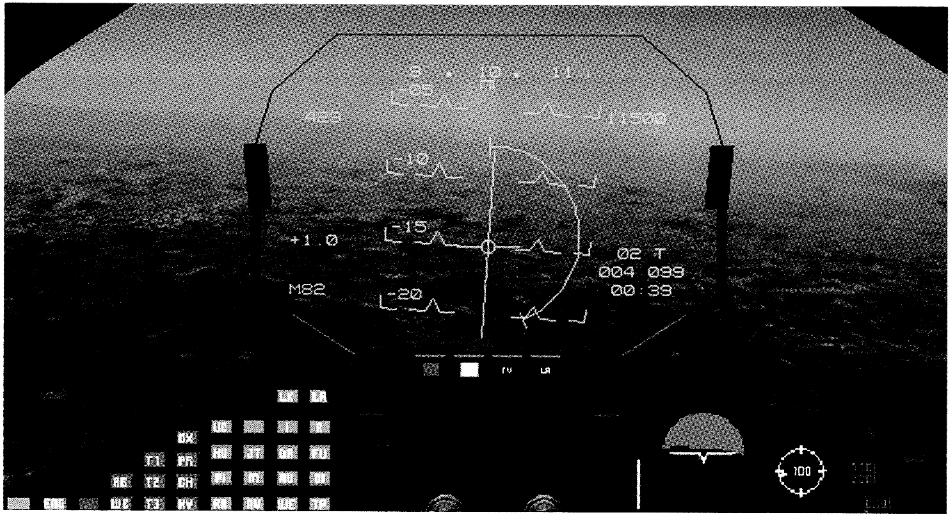
The ‘PADLOCK VIEW’ also slaves the targeting system of the ‘ASRAAM’ (Advanced Short Range Air-To-Air Missile), which you will be able to fire at an enemy even when you are looking over your shoulder.


TARGET PADLOCK
06:33:56
TARGET PADLOCK
06:34:16
06 34 50

**Keep your eyes on the bandits without losing control of your plane, thanks to the unique EF2000 ‘PADLOCK VIEW’ (F10)**

# EF2000 VIEWS

## EF2000 VIEWS IN USE



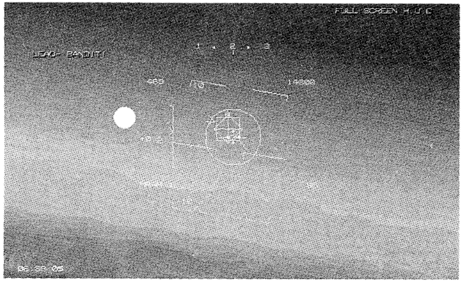
The default view of the cockpit. Note the IRST screen under the HUD (F1)

### HEAD-UP WITH COCKPIT VIEW

This is the default view in EF2000, and shows what the pilot sees when looking dead-ahead through the HUD. In this view, you will have access to both the HUD and the 'INFRA-RED SEARCH AND TRACK' (IRST) screen, which are both invaluable in combat within the 30 mile radius.

### HEAD-UP ONLY VIEW

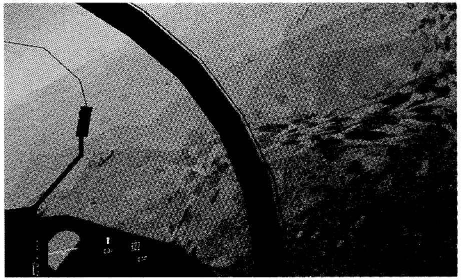
Modern fighter aircraft carry a video camera capable of taking pictures through the HUD. This view is exactly what the camera sees. It shows all the 'HEAD-UP DISPLAY' (HUD) symbology without the surrounding HUD and cockpit frame. This view also helps improve the frame rate on slower PCs. It's an extremely practical view in dogfights, and for approach and landing.



The 'HEAD-UP' view (F1)

# EF2000 VIEWS

## EF2000 VIEWS IN USE



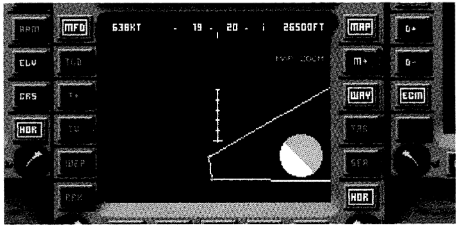
Scrolling the view with Shift cursor.

### MANUAL SCROLLING VIEWS

The best and most natural way to check what's outside your cockpit is with your 'Mark 1 eyeball'. This is especially useful when there's time enough for sightseeing, but could prove tricky in combat situations.

### 'HEAD-DOWN' VIEWS

The EuroFighter has three 'Multi-Function Displays' (MFDs), which provide the pilot with a wealth of information about the air picture, the outside environment and the plane's systems. Some of these screens need only a cursory glance; others require prolonged and careful study while flying the plane. You should practice switching between 'HEAD-UP' and 'HEAD-DOWN' views, because this will be important in difficult missions.

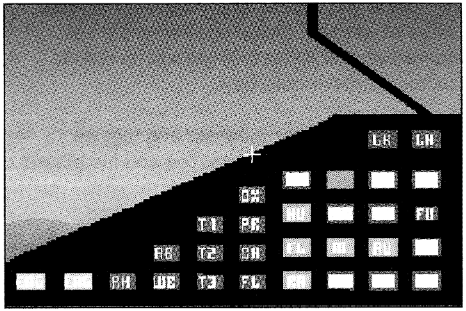


Heads down for radar, etc. (NUM 1,2,3)

To help you fly while looking at the MFD, check the 'ARTIFICIAL HORIZON' (see above). Use this together with the second line of information at the top of each MFD display, which shows your speed, heading and altitude. If you panic or become disorientated (which happens to real pilots too), simply press the 'L' key to return yourself automatically to level flight.

### GLARESHIELD VIEWS

You can access close-up views of the instrument panel sections shown in Head-Up mode. This includes the left-hand glare shield, with its bank of warning lights, the small IRST screen under the HUD, and the right-hand glare shield with its analog back-up instruments. The warning lights change colour, and give valuable indications to what is happening with the aircraft systems. It therefore pays to keep a close eye on them.



Close-up view of the warning panel (NUM 4)

# EF2000 VIEWS

## EXTERNAL VIEWS IN USE

EF2000 offers a wide variety of external views for you to enjoy. They are particularly useful in combat, to help you orientate yourself, or to observe the result of your tactics.

F3 - Executes a quick glance around the sky to check your six. This is handy when you have heard a missile warning, and want to check that an enemy aircraft has not sneaked up behind you.

F4 - Gives you access to a variety of external views of yourself, including several pre-set camera angles. Note that you will be able to zoom and pan in this view.

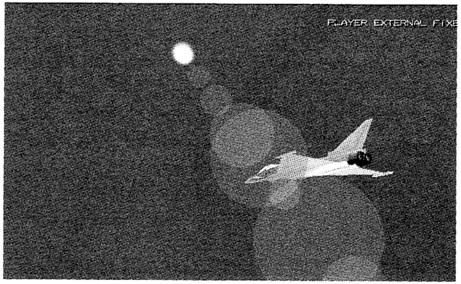
F5 - Shows you your wingman and toggles various views between him, you and his targets.

F6 - Fly-by views give you a dramatic and dynamic perspective on your flying- especially when a missile is chasing you! SHIFT F6 gives you access to browse plane fly-bys.

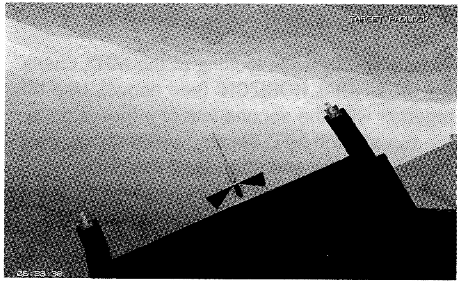
F7 - Access target views with this key, and watch what happens after you release your weapons.

F8 - A weapon's eye view, or external weapon view. Watch what happens when you drop cluster bombs!

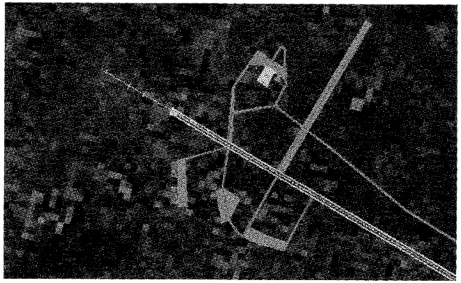
F9 - Take a look at any plane in the vicinity. Watch A10s killing tanks, or Tornados making airfield strikes.



**F4 Player external view.**



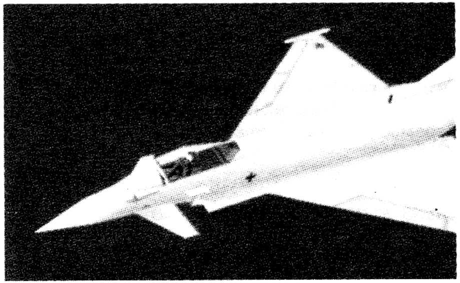
**F3 Check your six.**



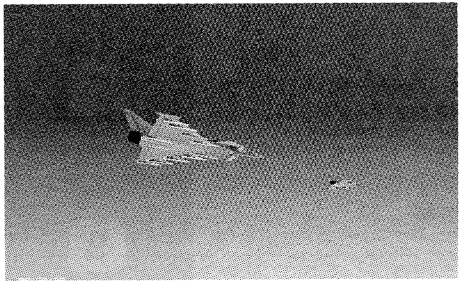
**SHIFT F4 Satellite view.**

# EF2000 VIEWS

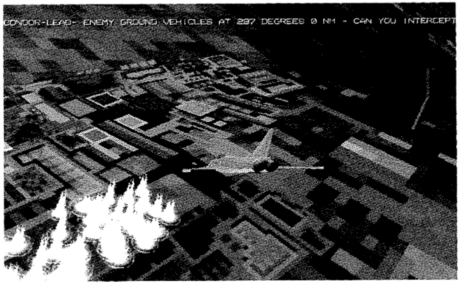
## EXTERNAL VIEWS IN USE



F5 Wingman view.

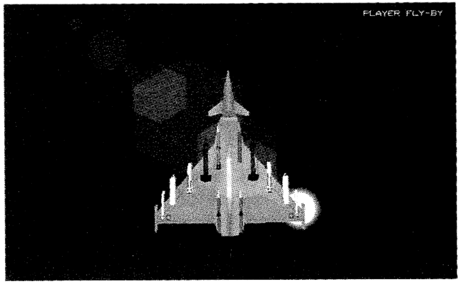


SHIFT F6 Wingman fly-bys.

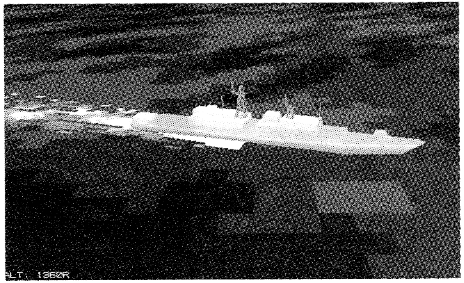


CONDOR-LEAD- ENEMY GROUND VEHICLES AT 287 DEGREES 0 NM - CAN YOU INTERCEPT

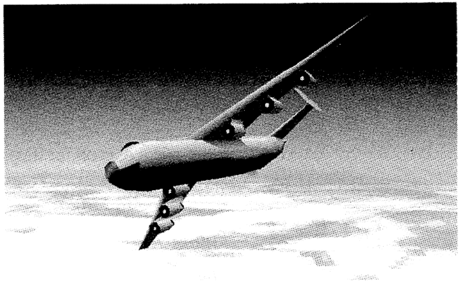
F8 Weapon view.



F6 Fly-by views.



F7 Target view.



F9 Browse plane view.

# EF2000 VIEWS

## OPERATING THE VIEWS

F1

### MAIN COCKPIT VIEWS

*PRESS 'F1'*

Toggles between the cockpit and HUD view, and the HUD only view. The latter view is recommended for slower machines, as it helps improve the frame-rate.

NUM 8

### RESTORE FORWARD COCKPIT VIEW

*PRESS '8' ON THE NUMERIC KEYPAD*

Returns you to the head-up view.

Shift F1

### HEADS DOWN VR COCKPIT

*PRESS SHIFT 'F1'*

This sets your view to the MFDs in the VR cockpit.

F2

### WIDE ANGLE VR COCKPIT

*PRESS 'F2'*

Wide angle cockpit for dogfighting.

F3

### CHECK YOUR SIX

*PRESS 'F3'*

Checks the sky behind you

NUM 7

### GLANCE LEFT

*PRESS '7' ON THE NUMERIC KEYPAD*

Positions your head so that you are looking sixty degrees through the left-hand-side of the canopy. Repeated pressing increments the view.

NUM 9

### GLANCE RIGHT

*PRESS '9' ON THE NUMERIC KEYPAD*

Positions your head so that you are looking sixty degrees through the right-hand-side of the canopy. Repeated pressing increments the view.

F4

### PLAYER EXTERNAL VIEWS

*PRESS 'F4'*

Toggles between a standard external view, and several pre-set camera views.

Shift F4

### SATELLITE VIEWS

*PRESS SHIFT 'F4'*

Satellite view gives you a high altitude view of your current position. It can be zoomed with the external view zoom keys described in this section.

# EF2000 VIEWS

## OPERATING THE VIEWS

F5

### WINGMAN VIEWS

*PRESS 'F5'*

Toggles between a full wingman external view, a view of the wingman and player, a view of the player and wingman, and a cockpit view from the wingman's plane.

F6

### PLAYER FLY-BY VIEWS

*PRESS 'F6'*

Lets you watch yourself fly-by.Also shows your plane and the nearest missile.

Shift F6

### TARGET AND BROWSE PLANE FLY-BY VIEWS

*PRESS SHIFT 'F6'*

An external view that lets you watch your target fly-by, or the nearest browse plane.

F7

### TARGET VIEWS

*PRESS 'F7'*

Toggles between a full target view, target and player view, player and target view, and a view of the target and his target.

F8

### WEAPONS VIEWS

*PRESS 'F8'*

Toggles between a full external view of the weapon, a view of the weapon and target, a view of the target and weapon, and a weapon's eye view.

F9

### BROWSE ANY PLANE VIEW

*PRESS 'F9'*

Switches between views of any plane in the vicinity.

F10

### VR PADLOCK

*PRESS 'F10'*

Puts you in the full VR cockpit, and enables you to padlock onto any enemy plane within 30 miles. It should be used in conjunction with the target cycle controls and also gives you access to the ASRAAM sight. Press twice for missile padlock.

NUM 1

### LOOK AT MFD 1

*PRESS '1' ON THE NUMERIC KEYPAD*

Lets you look at MFD1, used principally for radar.

# EF2000 VIEWS

## OPERATING THE VIEWS

NUM 2

### LOOK AT MFD 2

*PRESS '2' ON THE NUMERIC KEYPAD*

Lets you look at MFD2, used principally for JTIDS and Moving Map Displays (MMD).

---

NUM 3

### LOOK AT MFD 3

*PRESS '3' ON THE NUMERIC KEYPAD*

Lets you look at MFD 3, used principally for the Defensive Aids Sub-System and aircraft system displays.

---

NUM 4

### LOOK AT LEFT-HAND GLARESHIELD

*PRESS '4' ON THE NUMERIC KEYPAD*

Lets you look at the warning lights clustered on the left of the cockpit.

---

NUM 5

### LOOK AT THE IRST SCREEN

*PRESS '5' ON THE NUMERIC KEYPAD*

Gives you a close up view of the IRST display under the HUD.

---

NUM 6

### LOOK AT RIGHT-HAND GLARESHIELD

*PRESS '6' ON THE NUMERIC KEYPAD*

Lets you look at the analogue artificial horizon and compass, which you will need if the primary digital systems become damaged.

---

Shift ← →

### MANUAL SCROLLING VIEW HORIZONTAL

*PRESS 'SHIFT' AND THE 'LEFT ARROW' OR 'RIGHT ARROW' CURSOR KEYS*

This pans your view in the horizontal. It's great for sightseeing, but when there's danger about you should choose the padlock view.

---

Shift ↑ ↓

### MANUAL SCROLLING VIEW VERTICAL

*PRESS 'SHIFT' AND THE 'CURSOR UP ARROW' OR 'CURSOR DOWN ARROW'*

This pans your view in the vertical plane. This trick is especially useful in a turning fight to check your progress on the bandit.

---

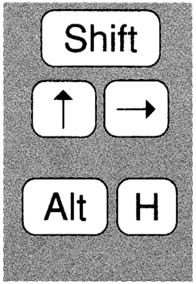
Shift 7 1

### EXTERNAL VIEW ZOOM

*PRESS SHIFT AND '7' OR '1' ON THE NUMERIC KEYPAD*

This lets you zoom in on external views, creating your own dramatic perspectives. Use in conjunction with the

## OPERATING THE VIEWS



external view panning described next.

### EXTERNAL VIEW PANNING

*PRESS 'SHIFT' AND THE CURSOR ARROW KEYS*

This lets you pan freely around the external views.

### HUD DECLUTTER

*PRESS ALT 'H'*

This lets you remove detail from the HUD, to let you enjoy any of the cockpit views without excess clutter.

# EF2000 AVIONICS

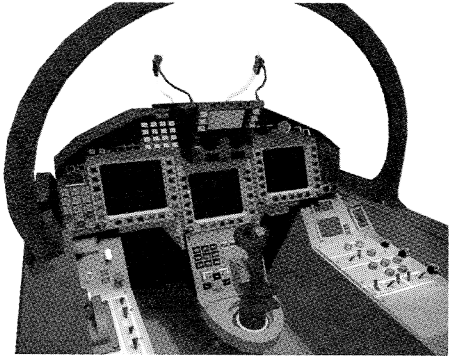
## AN INTRODUCTION TO THE EF2000 AVIONICS

As combat aircraft became increasingly sophisticated in their ability to detect, kill or evade threats, so the pilot workload increased. In some cases, this meant that aircraft required two seats; one for the pilot; the other for a weapons and electronics officer or 'Wizzo'. However, the specification for EuroFighter stated the need for a single seat plane, capable of performing tasks that might otherwise have required a two-seater. This demanded a fundamental re-think on the pilot-aircraft interface, at all levels, from Flight-Control System (FCS) to flight instrumentation. Target detection needed to be stealthier, more accurate, and more powerful, yet more automated. Defensive systems would have to 'think' for themselves, taking whatever precautions the situation demanded. Weapons systems would have to be more appropriate to changing situations, and have the performance to beat a new generation of agile aircraft. Navigation systems would have to do far more than just point-out the right direction.

On top of this, the phenomenal improvements in roll-rate, turn and climb meant increasing physical demands on the pilots themselves. The onset of G in a Hawk training aircraft is bad enough, but it is many times more severe in EF2000. This meant that accidents due to G-LOC (Gravity Induced Loss Of Consciousness) would be far more likely, and so recovery systems had to be installed as safety precautions.

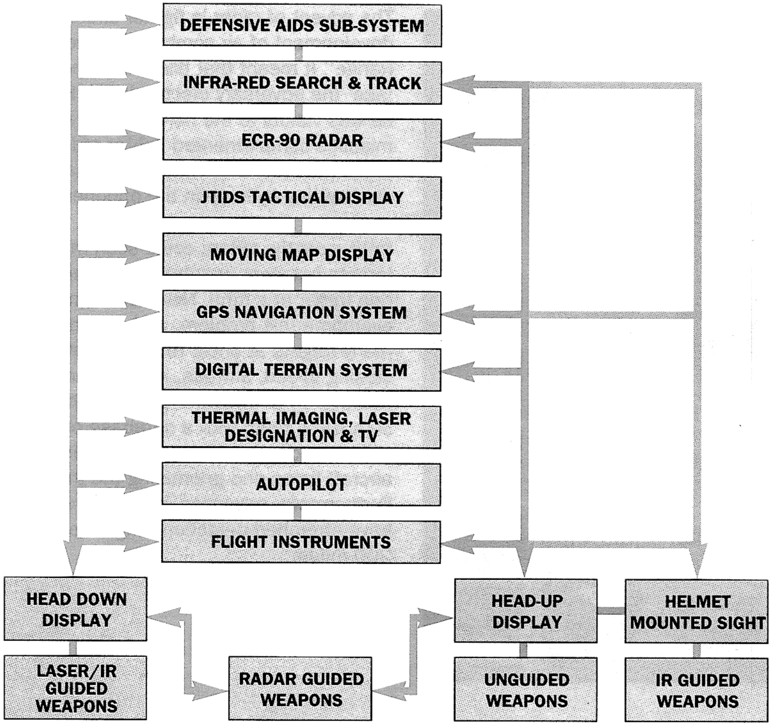
The EuroFighter's designers have tackled a great many of these problems in unique and novel ways. Not only is the aircraft easy to fly and virtually impossible to stall, its avionics provide a level of feedback never before seen in a multi-role fighter. That doesn't mean that EF2000 is simple to fly in combat – just a lot easier considering its awesome power and potential.

In EF2000, we have reproduced many of the systems found in the real EuroFighter, and laid them out in the cockpit as pilots would expect to find them. However, even if you choose not to employ the wealth of tactical data available to you, you'll still have a good chance of success by employing the basic systems. Because there is such a variety of systems to work with, you will also find your own special way of using them.



# EF2000 AVIONICS

## DISPLAY & WEAPON DELIVERY


DEFENSIVE AIDS SUB-SYSTEM
INFRA-RED SEARCH & TRACK
ECR-90 RADAR
JTIDS TACTICAL DISPLAY
MOVING MAP DISPLAY
GPS NAVIGATION SYSTEM
DIGITAL TERRAIN SYSTEM
THERMAL IMAGING, LASER DESIGNATION & TV
AUTOPILOT
FLIGHT INSTRUMENTS
HEAD DOWN DISPLAY
LASER/IR GUIDED WEAPONS
RADAR GUIDED WEAPONS
HEAD-UP DISPLAY
UNGUIDED WEAPONS
HELMET MOUNTED SIGHT
IR GUIDED WEAPONS

The diagram shows where the various weapons aiming systems will be displayed, and which avionics control those systems.

Learn to use your autopilot first, and activate this while you practise with the other displays and systems.

Keep the Defensive Aids Subsystem (DASS) activated at all times: it does most of the work of defending your aircraft automatically.

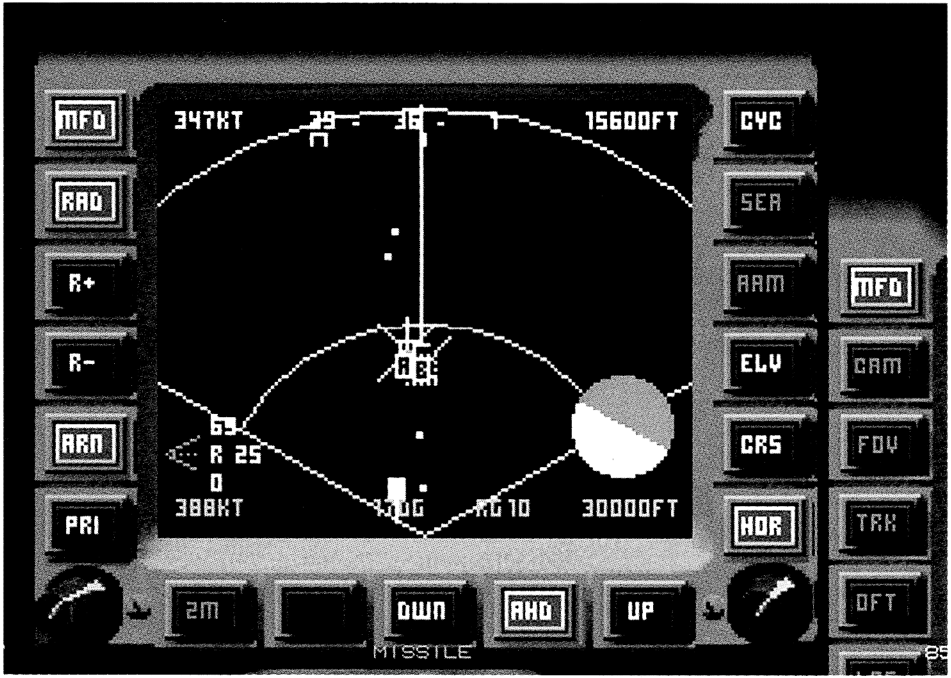
Learn to use your wingmen properly: when the battle begins, you need all the help you can get. Using your wingmen correctly will take a lot of pressure away from you.

Practise as much as possible using the simulator missions and the free-flight options.

Tips for Beginners

# EF2000 AVIONICS

## AN INTRODUCTION TO THE ECR-90 RADAR


MFD
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ELV
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MFD
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TRK
DFT
63
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388KT
30000FT
2M
DWN
AHD
UP
MISSILE
85

ECR-90 - the most versatile fighter radar in the West

The advent of radar in fighter aircraft lead to the development of air combat 'Beyond Visual Range'. It meant that pilots were now able to 'see' the adversary electronically, long before he was visible to the naked eye. Radar guided missiles complemented fighter radar, giving pilots the means to conduct combat without ever setting eyes upon the opponent.

Until recently, radars could scan multiple targets but were unable to track more than one target at a time. New developments have overcome this problem, and are able to track many targets at once, returning data on speed, closing speed, altitude, aspect, range and bearing. By analysing the radar echoes and comparing them with a database of signals, today's radar is even capable of distinguishing aircraft types and prioritising the threats. Furthermore, advances in signal processing have stretched detection ranges to well over 200 miles.

# EF2000 AVIONICS

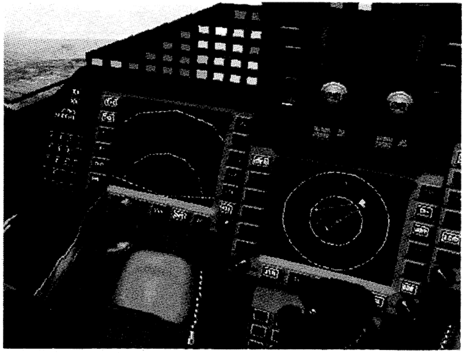
## AN INTRODUCTION TO THE ECR-90 RADAR

### 'LOOK AND LEARN' RADAR

The ECR-90 is distinguished by its ability to portray a complex air picture in a simple graphical way that is easier for the pilot to understand. In addition, it automates many of the functions that would traditionally require a great deal of button pushing, such as changing modes. It is also closely integrated with an IRST (Infra Red Search and Track) system, which is able to track air targets passively, and supplement radar data when enemy jamming is in progress.

In the real EF2000, voice control will also enable the pilot to summon-up a variety of data, simply by asking. This allows pilots to learn about the air-picture without having to make complex radar adjustments.

No radar is perfect, and in EF2000 we have reproduced some of the problems. Firstly ECR-90 is a Pulse Doppler radar which cannot see fast, low-level enemies crossing its path at 90 degrees. Contacts may therefore vanish for brief moments. Secondly, different radar targets have a different Radar Cross Section, which means that big planes show up much more easily than small, fighter-sized planes.



### A BRIEF HISTORY OF THE ECR-90 RADAR

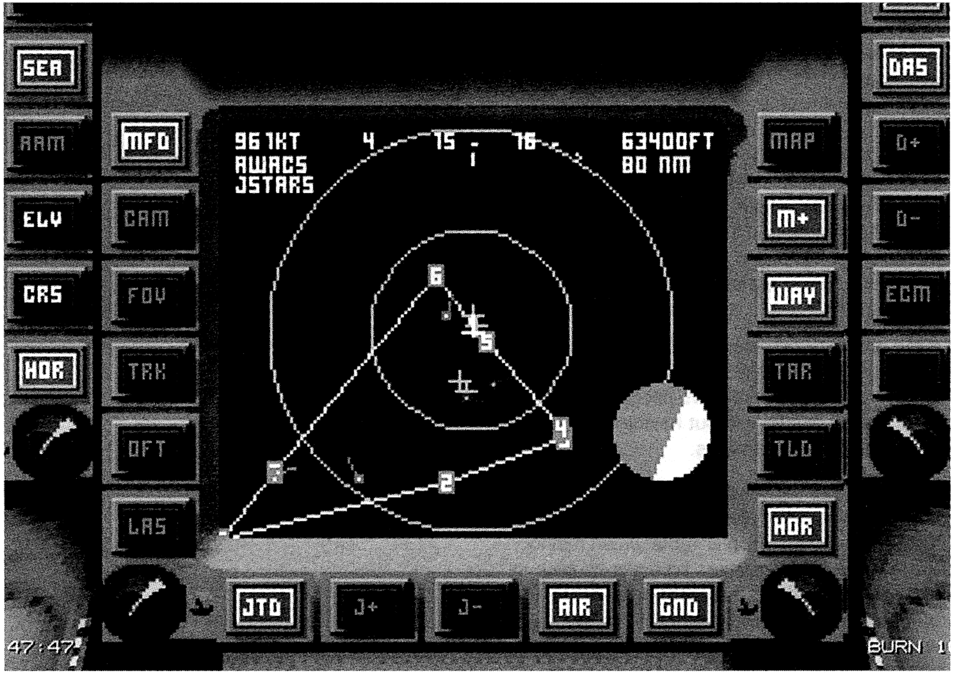
The ECR-90 radar for EF2000 has been developed by a consortium including Italy's FIAR Defence Division, Germany's Deutsche Aerospace and Spain's INISEL, lead by GEC-Marconi Avionics of Great Britain. ECR-90 is a 3rd generation coherent multi-mode radar based on the 'Blue Vixen' technology of the updated Sea Harrier. Signals are fed into a powerful processor, where many complex analyses are made in real-time, before being displayed as graphical symbology on colour, raster-cursive displays. Information such as aircraft type, speed, closing speed, heading and altitude are complemented by threat prioritisation, correct weapon allocation, and plotting of the best tactical flight path for weapons release.

# EF2000 AVIONICS

## THE ECR-90 RADAR IN USE

### CHOOSING BETWEEN RADAR AND JTIDS

Each time you use radar, you broadcast your position to every passive radar warning receiver for miles around. For this reason, a great deal of money has been invested in stealthy detection technology which does not rely on using fighter radar. The result is JTIDS, which stands for the Joint Tactical Information Distribution System, and which is described in detail in this manual. In simple terms, JTIDS gathers data from every allied electronic sensor in the theatre of war, including Airborne Warning and Control Systems (AWACS), builds a composite picture and beams this direct into the cockpit. Which means you see what AWACS and other systems see, without giving your position away. JTIDS will only work if the appropriate intelligence gathering aircraft are airborne. If this is the case, use JTIDS for monitoring the air-picture, until you need radar for launching weapons. This will help prevent your early detection by enemy Early Warning (EW) systems.


SEA
AAM
ELV
CRS
HOR
MFD
CAM
FOV
TRK
DFT
LAS
961KT
AWACS
JSTARS
4
15
16
63400FT
80 nm
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2
3
4
5
6
DAS
D+
D-
ECM
MAP
M+
WAY
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AIR
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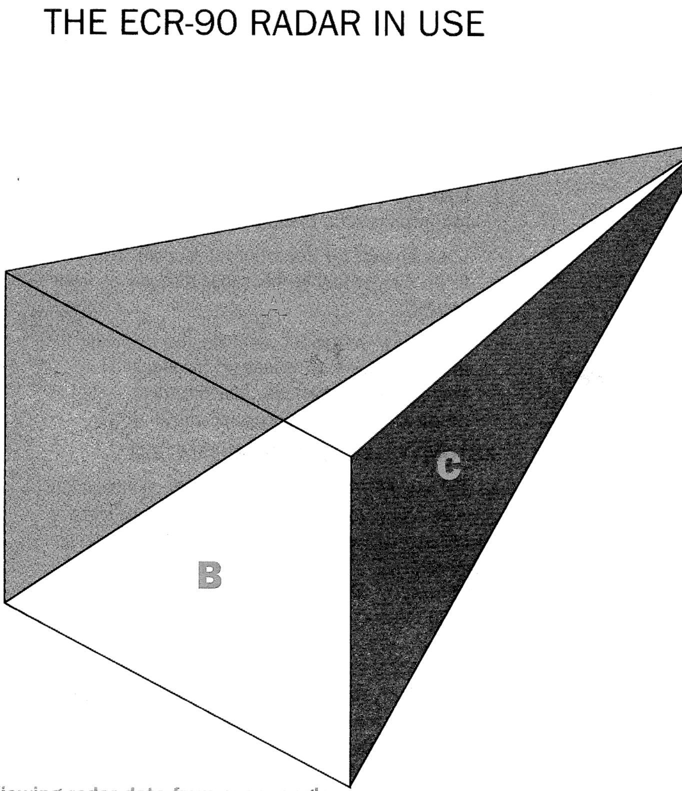
47:47
BURN 1

Using JTIDS instead of radar

# EF2000 AVIONICS

## THE ECR-90 RADAR IN USE



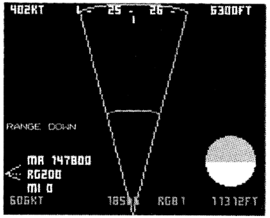
Viewing radar data from every angle

### BUILDING A 3D AIR PICTURE

Normally, radars display a pseudo plan-view of their beam pattern, which can be difficult to interpret. In the ECR-90, three views of the beam pattern are available: A, the more conventional plan view; C, a side elevation, which is very useful when you need to analyse relative altitudes; and B, which is a cross section, or boresight view, of the radar picture and useful in determining enemy altitude and movement across your flight path.

NOTE: Centering targets in the 'B' view will bring them into your HUD view.

A


402KT
25
26
6300FT
RANGE DOWN
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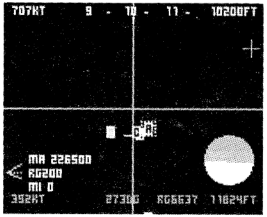
RG200
MI 0
606KT
RG81
11312FT

B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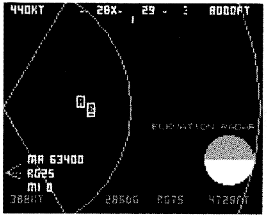
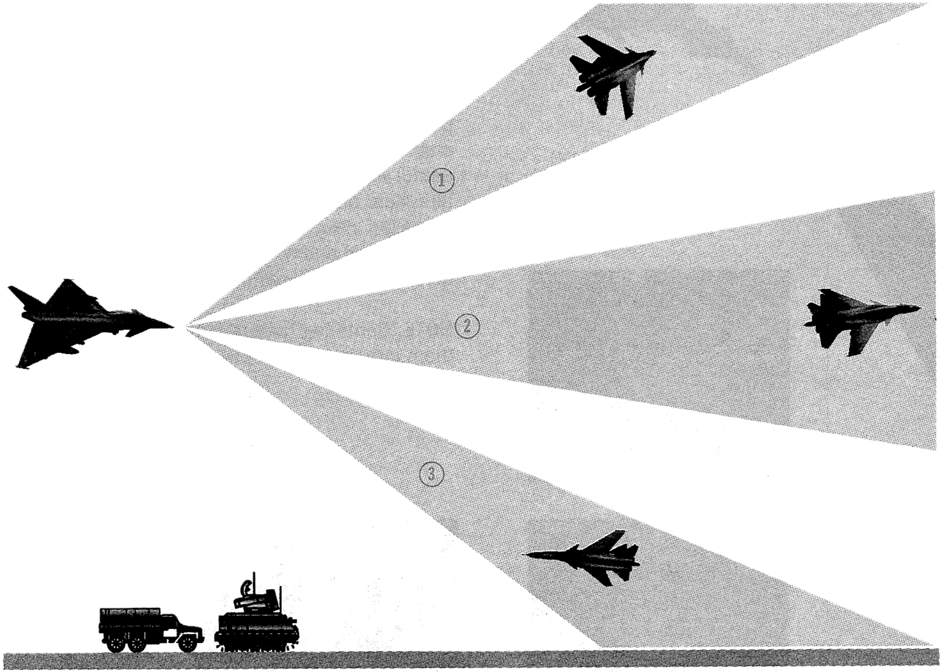
RG6637
11824FT

C


440KT
28X
29
8000FT
ELEVATION RADAR
MA 63400
RG25
MI 0
388KT
28506
RG75
4728FT

# EF2000 AVIONICS

## THE ECR-90 RADAR IN USE



Look-up, look-ahead and look-down radar

### LOOKING IN THE RIGHT PLACE

It is possible to alter the scan of the ECR-90 radar in order to provide optimum scanning of the sky ahead. Three settings are provided:

① Look-up mode, for detection of high-flying reconnaissance planes and bombers;

② Look ahead, for detection of aircraft likely to be flying roughly the same altitude as your aircraft;

③ Look-down mode for catching the devious low-flying bomber, intent on breaking through your defences. The different mode is shown by a symbol in the MFD.

### AUTOMATIC THREAT PRIORITISATION

In the real EF2000, the ECR 90 will prioritise the greatest threats, by dividing the range of each target by its closing speed, to give a Time To Go number (TTG). The smaller the TTG, the greater the threat. In EF2000, six targets are prioritised, in order to maintain the clarity of display, especially at low resolution. Targets with the smallest TTG are marked with the letters A, B, C, D, E, or F. If your mission is to detect bombers, the ECR-90 will also filter information to detect only that target type.

## THE ECR-90 RADAR IN USE

### WEAPONS SELECTION

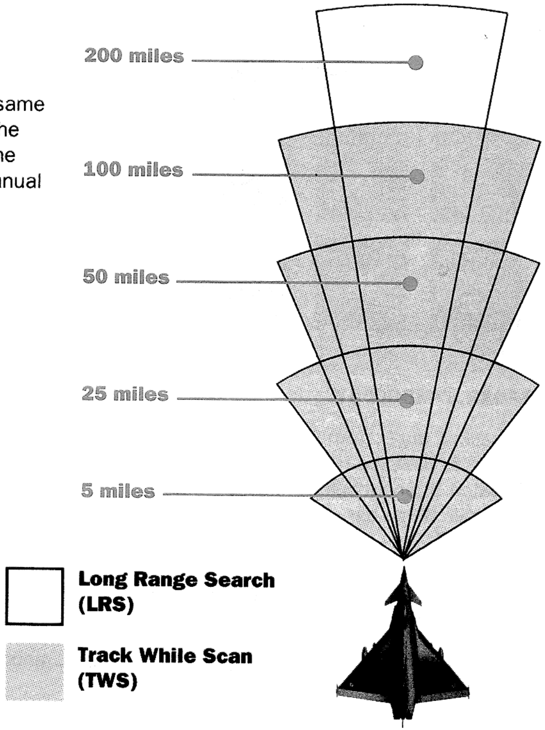
Use the ENTER key to scroll through available AA weapons. Selecting the appropriate weapon depends upon range to target. At ranges of 70 nm or less, select S-225 as first choice, with AIM 120 AMRAAM as second choice; at ranges of 30 nm or less, select AMRAAM as first choice, ASRAAM as second choice. At ranges of 10 nm or less, select ASRAAM as first choice, or AIM 9M Sidewinder as second choice. At 2 nm or less, use the cannon.

### AUTOMATIC IFF (IDENTIFICATION FRIEND OR FOE)

The radar automatically discerns whether a tracked target is a friend or foe, and displays an appropriate symbol: red for hostiles, green for friendlies. The pilot does not have to worry about pressing an IFF button to interrogate a target. Missiles are shown as yellow squares.

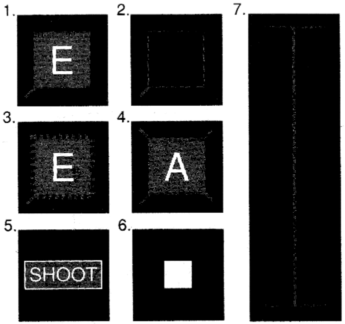
### AUTORANGING RADAR

Once the radar has detected targets, it will employ Autoranging to keep the blips within optimum radar range. It works in much the same way as an autofocus camera, and relieves the pilot of another basic task. Autoranging is the default setting, but can be overridden by manual ranging.



# EF2000 AVIONICS

## THE ECR-90 RADAR IN USE



MFD radar symbology

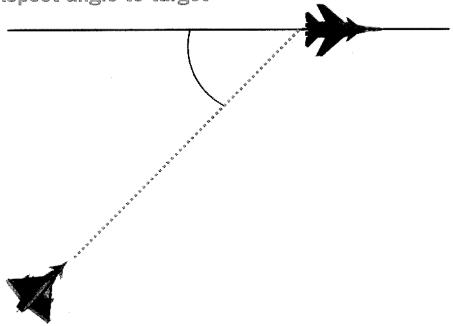
### RADAR SYMBOLOGY

1. Tracked target (red) 2. Tracked friendly (green) 3. Selected target 4. Target with missile allocated 5. Shoot cue 6. Missile (yellow).
7. Missile range bar.

Tracked targets are prioritised with letters A to F. The small tail on a tracked plane indicates the direction from which it is travelling.

One of the most important symbols on the radar is the missile range bar, which will vary in length depending upon altitude and your aspect to the target Flying high and head-on to target gives the best range. When you have an AA missile selected, you must ensure that the target is within the reach of this line. Once the target is in range, the symbol will change to indicate a lock, and the 'SHOOT' cue will appear. If you or your wingmen decide to fire, an X will appear around the symbol to indicate that a missile has been allocated. You will then be free to engage another target.

Aspect angle to target



### JAMMING RESISTANCE

Since the introduction of radar, counter technologies have been developed to jam its signals and 'spoof' missiles. The two main methods are frequency jamming and chaff (see the section on the Defensive Aids Sub-System for more details). The ECR-90 employs automatic techniques to counter jamming and chaff, by comparing inputs from different sensors.

### RADAR INFORMATION ON THE HUD

Pilots of single-seat aircraft cannot afford to spend all their time staring down into the cockpit, so there is a direct correlation between what is displayed on the MFD, and what is shown in the Head Up Display (HUD). For example, tracked targets are shown as boxes. For more information see sections on the HUD and using radar guided weapons.

## THE ECR-90 RADAR IN USE

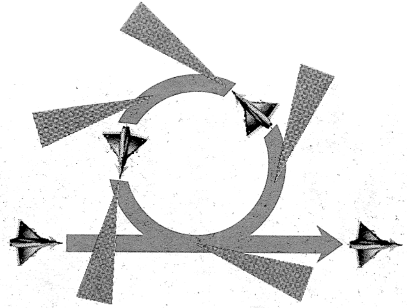
### THE MANOEUVRING ATTACK SYSTEM

With the autopilot set to TRACK mode, your aircraft will automatically set its course towards any locked aircraft currently awaiting assignment of a weapon. With the autofire cannon, this will enable you to destroy targets at close range with devastating precision. This system was first tested in an F-15, and proved that it is possible to destroy violently manoeuvring air-targets at ranges up to two miles with the help of automated systems.

### ACHIEVING FULL RADAR COVERAGE

Radar only scans a portion of the sky in front of you, so it is important to fly a circular course every twenty miles or so, in order to check that nothing has appeared behind you. To do this, make a note of your heading, then put the aircraft into a shallow turn. Try to maintain altitude as you do this by looking at the Horizon Ball in the MFD, and monitoring your altitude in the top right-hand corner of the MFD.

If you reach your original heading without detecting any bogeys, continue for another twenty miles or more and repeat the exercise.

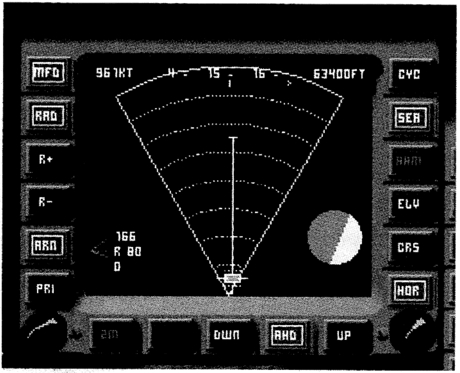


Using radar to check your six

In Combat Air Patrol missions, you will fly a route that achieves all round coverage of your sector.

### SEA EAGLE RADAR MODE

Selecting this Air-to-Ship weapon will automatically set the ECR-90 to a special SEA mode, which is a plan-only view. It will detect surface ships at ranges up to 100 miles. Ship targets are selected in exactly the same manner as air targets, using the cycle button, and information on the ship type is shown at the bottom of the MFD in red.

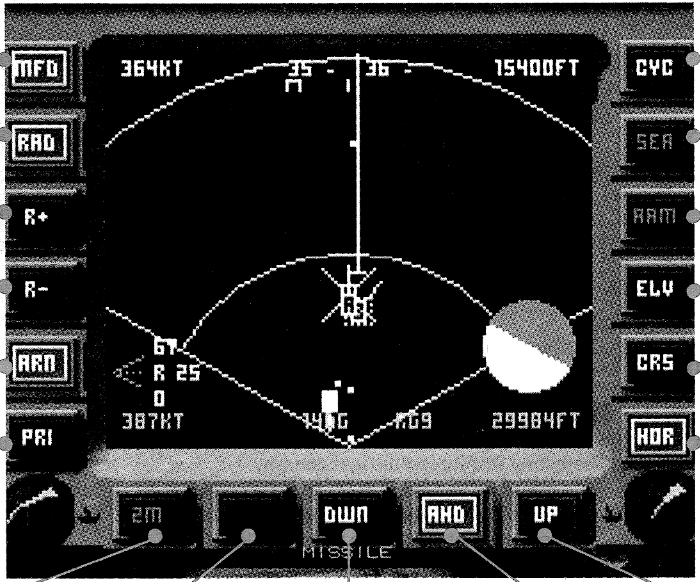


Sea Eagle radar mode

Once you have achieved a lock, you may zoom the image to see a clearer picture.

# EF2000 AVIONICS

## OPERATING THE ECR-90 RADAR


MFD
RAD
R+
R-
ARN
PRI
364KT
35
36
15400FT
67
R 25
0
387KT
29984FT
CYC
SEA
AAM
ELV
CRS
HOR
ZM
DWN
AHD
UP
MISSILE

**MFD on/off**

**Radar on/off**

**Increase radar range**

**Decrease radar range**

**Autorange mode**

**Prioritise targets**

**Cycle locked targets**

**Sea Eagle radar mode**

**Cycle AA missiles**

**Elevation radar**

**Cross-section or boresight**

**Artificial horizon on/off**

**Zoom function**

**Spare for upgrades**

**Look-down mode**

**Look-ahead mode**

**Look-up mode**

# OPERATING THE ECR-90 RADAR

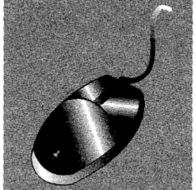
NUM 1

R

### ACCESS THE CORRECT MFD

*PRESS '1' ON THE NUMERIC KEYPAD, OR 'R'*

In EF2000, the three available views of the ECR-90 data are displayed on the left-hand Multi-Function Displays.



Ctrl A

### USE THE MFD

*POINT AT MFD BUTTONS WITH THE MOUSE AND SELECT WITH THE LEFT-MOUSE BUTTON, OR USE CTRL AND LETTER KEYS*

Once the MFD is active, you will have access to the various buttons around it by using the mouse or key sequence. When the mouse is over the MFD buttons, it has a box shape, which indicates that you can activate buttons by pointing and clicking. When the cursor is over the screen itself, it changes to a cross. At the top of the screen, the speed, heading and altitude of your aircraft are displayed. At the bottom of the screen, the speed, heading and altitude of selected target aircraft are displayed.

Z

### ZOOM SEA RADAR

*PRESS 'Z' OF THE MFD*

Allows you to zoom the Sea Eagle radar image.

RAD

### SWITCH THE RADAR ON/OFF

*PRESS 'RAD' ON THE MFD*

If you don't have to use your radar, remember to switch it off, in order to avoid detection by hostiles. Radar 'off' is the default mode for you and your wingmen, so remember to ask them to activate radar when danger is approaching.

ARN

### CHANGE RANGE AUTOMATICALLY

*PRESS 'ARN' ON THE MFD*

The default setting of the ECR-90 radar is with 'AUTORANGE' on.

R+ R-

### CHANGE RANGE MANUALLY

*PRESS 'R+' or 'R–' ON THE MFD*

From time to time, you may want to control the range manually, so simply press the appropriate key to increase or decrease range.

CYC

C

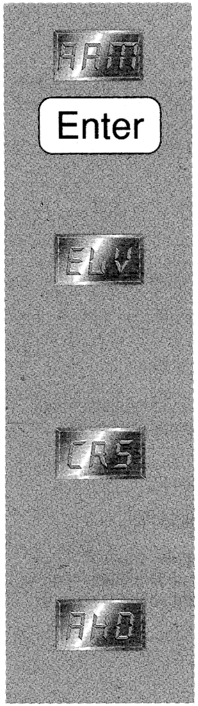
### CYCLE BETWEEN LOCKED TARGETS

*PRESS 'CYC' ON THE MFD OR PRESS 'C'*

To interrogate different locked targets, press this key. The selected target is highlighted on the MFD, and the relevant information is shown in red at the bottom of the screen.

# EF2000 AVIONICS

## OPERATING THE ECR-90 RADAR



### CYCLE BETWEEN AA MISSILES

*PRESS 'AAM' ON THE MFD OR 'ENTER'*

You may want to change the type of AA missile you are using, and override the automatic selection. As you switch weapons, you will notice the range bar changing in size to reflect the different ranges.

### CHANGE TO ELEVATION VIEW

*PRESS 'ELV' ON THE MFD*

To get an assessment of relative altitudes, switch to the elevation view. It is a particularly important view when you are trying to improve missile ranges by gaining altitude.

### CHANGE TO CROSS-SECTION VIEW

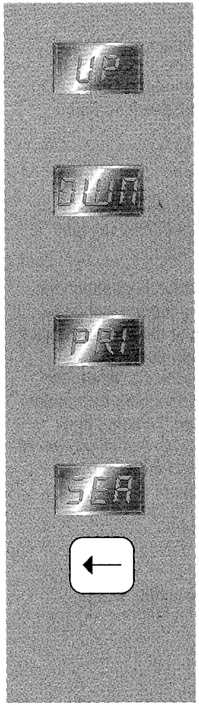
*PRESS 'CRS' ON THE MFD*

When chasing an enemy using the plan view radar, and the target makes a sudden move to the left or right, switching to the sectional view will show you whether he is diving for cover, or zooming in preparation for a return attack.

### CHANGE TO LOOK-AHEAD MODE

*PRESS 'AHD' ON THE MFD*

To return to the default look-ahead setting after using one of the other settings.



### CHANGE TO LOOK-UP MODE

*PRESS 'UP' ON THE MFD*

To search for high-flying targets, such as bombers or reconnaissance aircraft, select the look-up mode.

### CHANGE TO LOOK-DOWN MODE

*PRESS 'DWN' ON THE MFD*

To capture fast, low-level interdiction flights by enemy aircraft, switch to the look down mode.

### PRIORITISE TARGET TYPE

*PRESS 'PRI' ON THE MFD*

To determine which of the tracked targets are bombers, select this mode. It is designed for missions where your priority is to stop enemy interdiction.

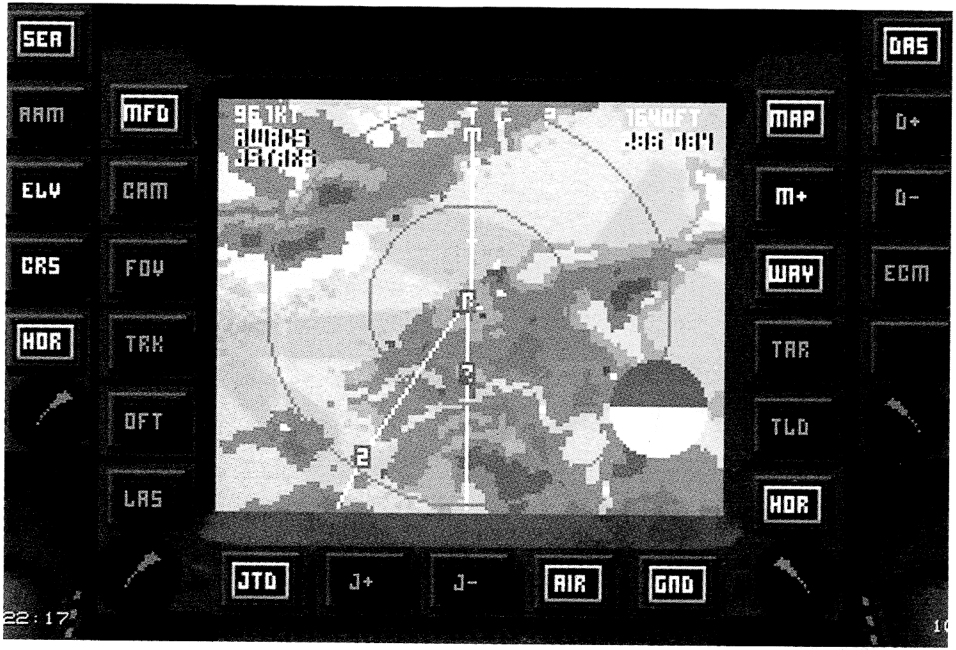
### SEA EAGLE MODE

*SELECT SEA EAGLE USING THE 'BACKSPACE' KEY OR 'SEA' ON THE MFD*

Selecting this Air-to-Ship weapon will automatically set the ECR-90 to a special SEA mode, which is a plan-only view. It will detect surface ships at ranges up to 100 miles. Selection of targets uses exactly the same method as AA weapons.

# EF2000 AVIONICS

## AN INTRODUCTION TO THE JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM



JTIDS - integrating battlefield data

An important trend in tactical display systems is to provide all combatants with an up-to-date picture of enemy and friendly positions in the entire theatre. This means collecting data from all major sensors operating in the battle environment, integrating them into one picture, then relaying that picture directly to the pilots and commanding officers. The sensors are principally AWACS, the Airborne Warning and Control System, and the Joint Surveillance and Target Attack Radar System, which was first battle-tested in the Gulf War. Secure transmission of the data to all parties is handled by the Joint Tactical Information Distribution System (JTIDS).

The advantages are that the combatants do not have to rely on radar (which gives their position away) and that they have access to information on what's going on around them, which could never be done with localised sensor systems alone. Another major advantage is that force commanders can be sure that everyone involved is getting the same big picture, and is able to react swiftly to changing local conditions.

## AN INTRODUCTION TO JTIDS

### AWACS

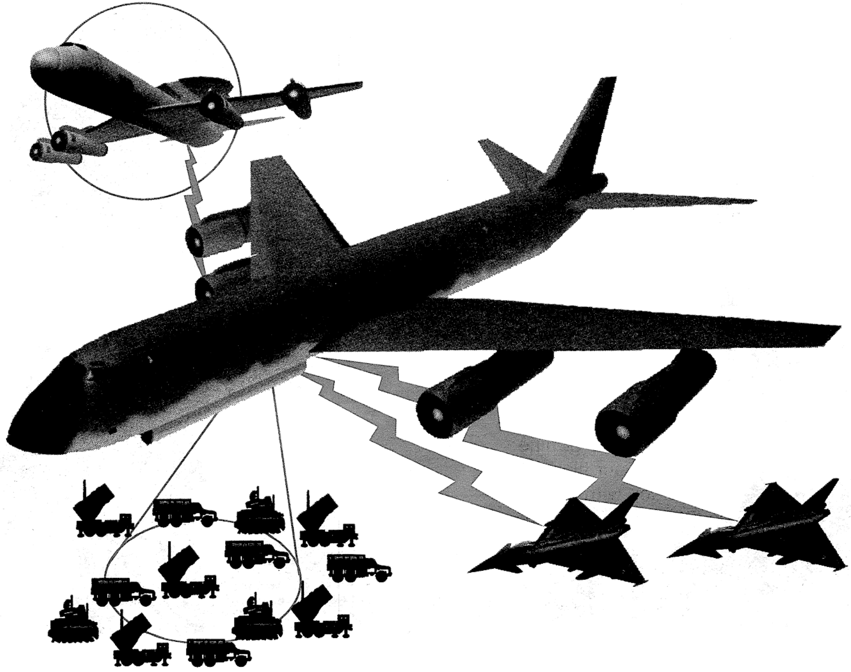
AWACS, or 'Magic' to pilots, provides an accurate air picture over a 300 mile radius, and directs aircraft to intercept bogeys. Originally designed to monitor the Warsaw Pact countries, AWACS proved invaluable in the Persian Gulf War, and in peacekeeping operations over the Balkans.

### JOINT STARS

The E-8 JSTARS (Joint Surveillance Target Attack Radar System) aircraft was rushed into service during the Gulf War, while still a prototype. It is the ground-watching equivalent of AWACS, able to detect second-echelon ground concentrations far behind enemy lines.

### JTIDS

JTIDS replaces voice communications with high-volume pulses of coded digital information. These are fired in short bursts using fast frequency hopping techniques for outstanding resistance to jamming. JTIDS terminals are now installed in all major combat and surveillance vehicles, from AWACS itself to EF2000.



How the information flows with JTIDS

## JTIDS IN USE

### JTIDS VERSUS RADAR

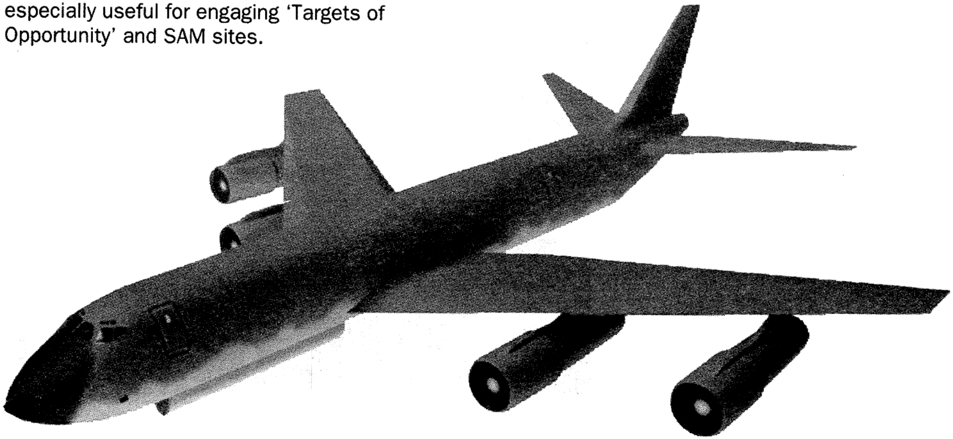
Wherever possible, use JTIDS in preference to radar, because it does not give your position away to the enemy. It makes you stealthy'. It also provides you with an all round picture of the combat environment. JTIDS will display all hostile aircraft, ground mobiles and ships detected by AWACS and JSTARS. If either of these planes is shot down, the relevant aspects of the JTIDS picture will disappear, forcing you to rely on your radar once more. It is always worth double-checking your JTIDS data from time to time, by comparing it with the ECR-90 radar picture.

### TACTICAL OVERLAYS

JTIDS lets you display your waypoint route on the tactical picture, helping you to determine where threats may occur during your flight. Double checking this information with the DASS will tell you where active EW and SAM radars are located. In addition, you can de-clutter the display by turning air and ground threats on and off. This is worthwhile in case air targets are obscuring an immediate ground-based threat. Range can also be adjusted, with the smaller scales providing the clearest display of the immediate battle zone. Crosses represent ground threats. Squares represent aircraft. Red is for the enemy, green is for friendlies

### JTIDS AND THE MMD

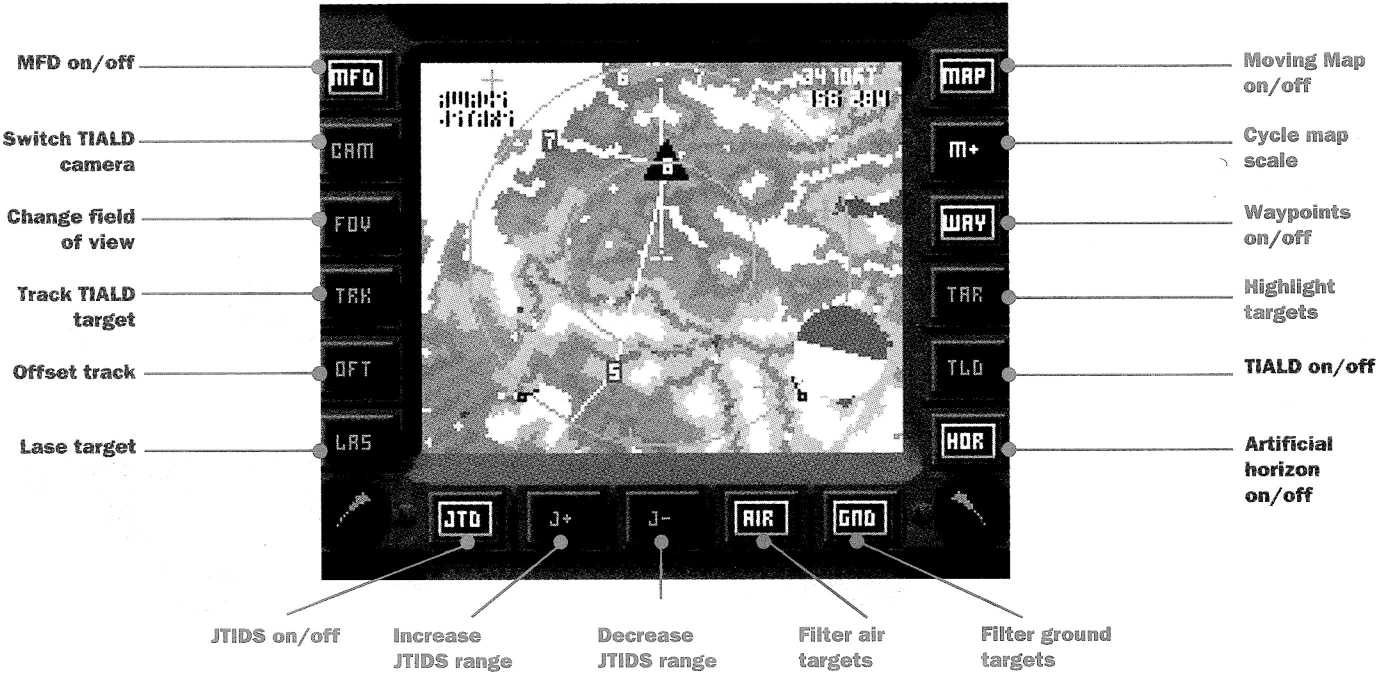
You can also overlay JTIDS data onto the moving map, enabling you to pinpoint the exact geographic locations of different threats. This is especially useful for engaging 'Targets of Opportunity' and SAM sites.



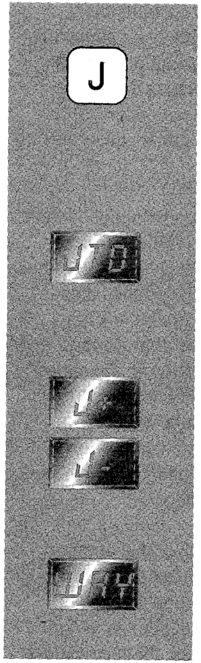
JSTARS

# EF2000 AVIONICS

## OPERATING JTIDS


MFD on/off
Switch TIALD camera
Change field of view
Track TIALD target
Offset track
Lase target
Moving Map on/off
Cycle map scale
Waypoints on/off
Highlight targets
TIALD on/off
Artificial horizon on/off
JTIDS on/off
Increase JTIDS range
Decrease JTIDS range
Filter air targets
Filter ground targets
MFD
CAM
FOV
TRK
OFT
LAS
MAP
M+
WAY
TAR
TLD
HOR
JTD
J+
J-
AIR
GND

## OPERATING JTIDS



### ACCESSING THE CORRECT MFD

*PRESS 'J'*

In EF2000, JTIDS is displayed on the centre Multi-Function Display. Press the appropriate key to access this MFD.

### SWITCHING JTIDS ON/OFF

*PRESS 'JTD' ON THE MFD*

The default is off, but JTIDS can be on at all times during missions. Selection of other displays other than the map will cancel JTIDS, which may be re-activated by pressing the appropriate key.

### CHANGING RANGE MANUALLY

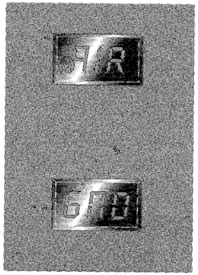
*PRESS 'J+' or 'J–' ON THE MFD*

This will allow you to zoom in on the threat picture. When nearby threats are overlaid, zooming-in should help to separate the signals.

### WAYPOINTS OVERLAY

*PRESS 'WAY' ON THE MFD*

This lets you see your mission waypoint route.



### TOGGLE AIR TARGETS ON/OFF

*PRESS 'AIR' ON THE MFD*

This lets you declutter the display, and search for ground targets obscured by the air targets.

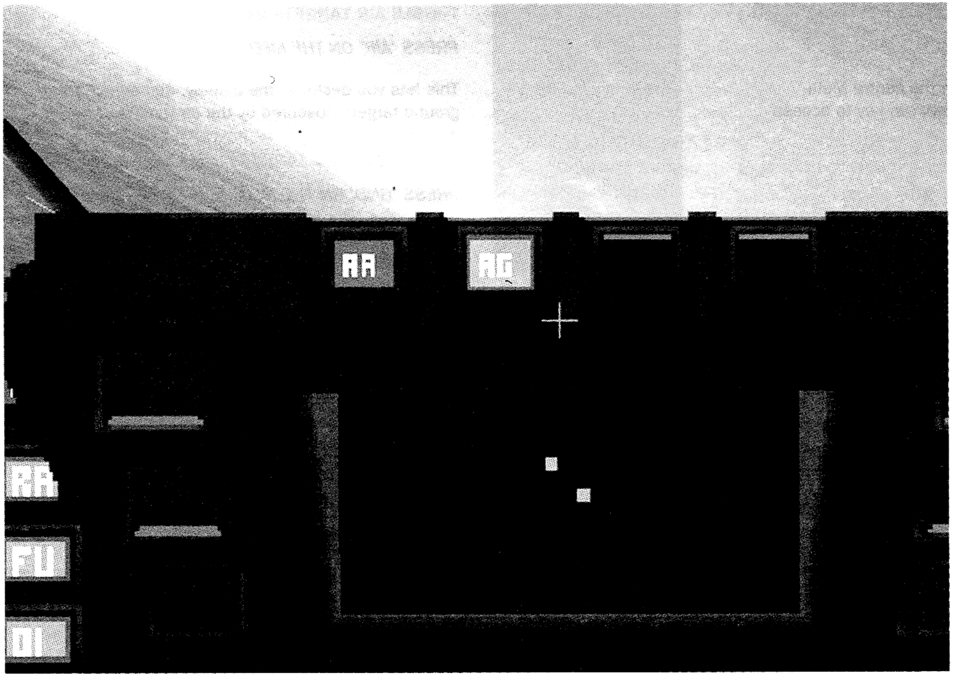
### TOGGLE GROUND TARGETS ON/OFF

*PRESS 'GND' ON THE MFD*

This lets you declutter the display, and makes only ground targets visible

# EF2000 AVIONICS

## AN INTRODUCTION TO THE INFRA-RED SEARCH & TRACK EQUIPMENT



IRST allows stealthy detection of enemies

Years before Western powers considered it worthwhile, the Russians were busy integrating Infra-Red Search and Tracking equipment into their front line fighters. This enabled them to acquire and track targets without resorting to radar, which always gives the game away with its tell-tale emmissions.

Planes like the MiG-29 are able to make 'covert' attacks on enemies, getting close enough to ensure a high Probability of Kill (PK) without their opponents ever knowing that they were there. IRST works by detecting differences in heat emitted by various objects, and that doesn't only mean hot jet pipes. Consider that at absolute zero, minus 273.15 degrees centigrade, 0 degrees Kelvin, the IR scanner would see nothing; an iceberg by contrast would have a difference in temperature of between 230K and 280K, so would be clearly visible.

IRST is therefore capable of showing detailed visual information over an estimated distance of 25 miles. This information can be filtered by software to provide a radar-like display of air targets, or enhanced to produce TV-like images of air and ground vehicles.

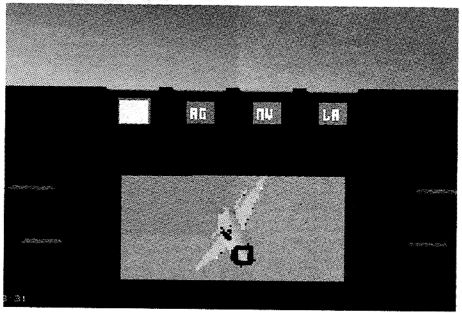
# IRST IN USE

In EF2000, IRST serves two practical purposes. Firstly it is capable of detecting targets and tracking them in a similar fashion to radar, without giving the EF2000's position away. Secondly, it is capable of generating TV quality images, which can be used for target identification. For example, hot airborne targets within 25 miles will appear as small points of white light. If then acquired by an IR missile's seeker head, the target will be enlarged on the display to make target identification easier. The IRST head is gyroscopically stabilised, so the image will remain steady during manoeuvring, although the limit of its field of vision is 170 degrees.

In ground-attack modes, IRST also doubles as Forward Looking Infra Red (FLIR) guidance for Mavericks. On acquisition of 'hot' ground targets, the view is enlarged automatically in the small screen below the HUD, to show what has been targetted prior to release of the weapon. The seeker head is gimballed, to allow a very wide field of regard.

## IDENTIFICATION OF TARGETS

The 'IRST' display works like a crude radar to a range of around 30 nautical miles. It also helps you identify targets visually. Phantom F4 pilots on air-defence duty sometimes carried a small telescope to help confirm distant visual sightings. The IRST screen does virtually the same job. Simply let an IR missile lock-on to a target that's within visual range in the HUD, but is to small to be recognisable; a zoomed image of the tracked plane will appear in the screen. If you are lucky and your aircraft recognition skills are good, you should be able to identify the target.



Target imaging on IRST

### A BRIEF HISTORY OF PIRATE

In the real EuroFighter, IRST is part of the The Passive Infra-Red Airborne Track Equipment (PIRATE), which is designed to detect and track several targets simultaneously at estimated ranges of around 30 miles. Scanning is in the 3 – 8 and 8 – 11 micron wavelengths, using signal processing techniques from the latest anti-aircraft missile systems. Like many other major EF2000 systems, PIRATE is the responsibility of a consortium from the four member nations of the EF2000 project.

## OPERATING THE IRST

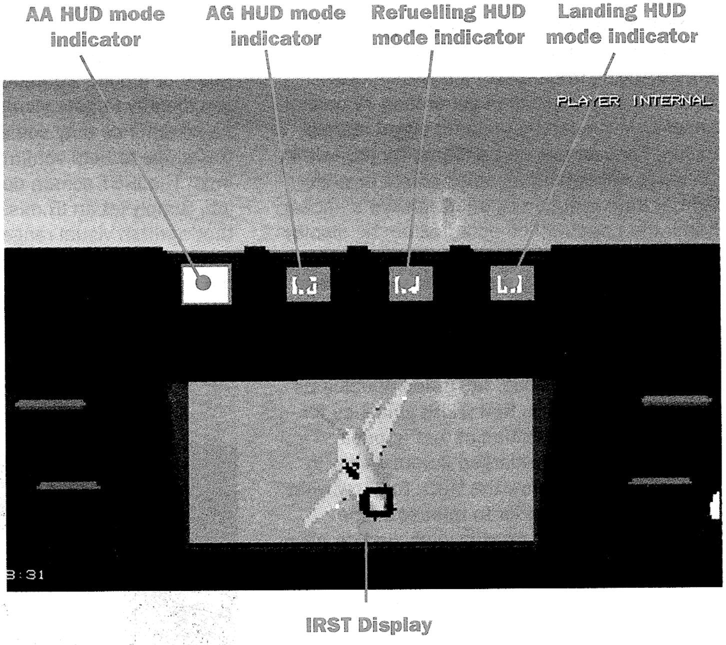
NUM

5

### ZOOMING ON THE HUD MONITOR

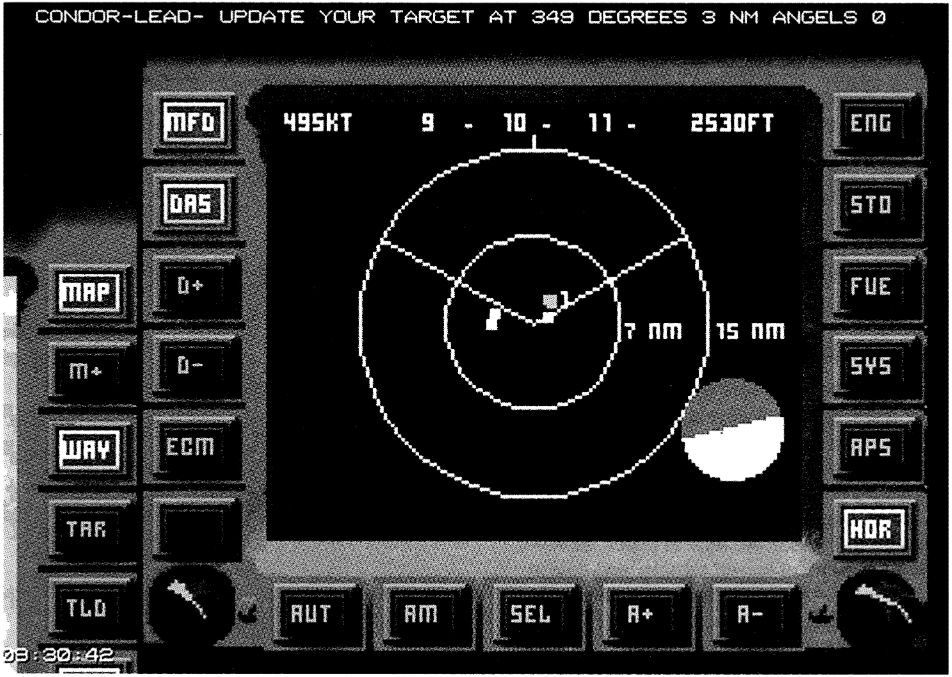
*PRESS '5' ON THE NUMERIC KEYPAD*

IRST is constantly active and displayed on the small screen under the HUD. For a close-up view of this screen, press the appropriate key or switch to an MFD view.


AA HUD mode indicator
AG HUD mode indicator
Refuelling HUD mode indicator
Landing HUD mode indicator
PLAYER INTERNAL
IRST Display

# EF2000 AVIONICS

## AN INTRODUCTION TO THE DEFENSIVE AIDS SUB-SYSTEM (DASS)



CONDOR-LEAD- UPDATE YOUR TARGET AT 349 DEGREES 3 NM ANGELS 0

DASS helps automate the job of defending the aircraft

The time that pilot's most need to operate defensive systems is precisely the time of highest stress in the cockpit. . . the time when the plane is under attack. Because the task of orchestrating counter-measures and defensive systems has become so complex in single-seat fighters, the EF2000 designers realised the need for intelligent automation. The result of their efforts is know as the Defensive Aids Sub-system (DASS). It integrates an advanced radar warning receiver (RWR), an IR warning receiver (IRWR), a laser warner, a towed decoy, automatic IFF (identify friend or foe), the ability to select and jam threats, and an automatic release mechanism for chaff and flare. Most significantly, EF2000 is the first fighter in which a complete suite of defensive measure has been incorporated into the aircraft design. No external pods are necessary, allowing a greater weapons payload.

# EF2000 AVIONICS

## AN INTRODUCTION TO THE DEFENSIVE AIDS SUB-SYSTEM (DASS)

### RADAR COUNTERMEASURES

In the Second World War, the technique of jamming radar with 'Chaff' was developed (code named 'Window' by Britain, and Düppel by Germany). Chaff comprises strands of radar reflective material cut to the same wavelengths as those used by the target radar. This creates a false echo on the radar which is capable of fooling enemy pilots and radar guided missiles. Chaff has proved so effective that it's still in use today, fired in small canisters out of the rear of the aircraft. One hundred and fifty such canisters are kept on board the EF2000, and DASS takes care of releasing them automatically, at just the right moment.

Another technique for dealing with radar is jamming, in which the defender emits high energy signals at the same frequency as the attacking radar. On older radar screens, jamming appears as snow, making it impossible to see the real returns. A subtler technique is known as 'deception jamming', and attempts to confuse enemy radar by creating false returns. DASS offers both techniques, and controls their use automatically. However, you should remember that using ECM makes your presence known to everyone in the area.

### IR COUNTER MEASURES

Defences against Infra-Red guided missiles are primarily based on flares. The drawback is that modern missiles are highly tuned to the IR frequencies emitted by the jet pipes of different aircraft, and can distinguish between exhaust and flare. Another problem is the flare's short burn-time, which is why flares are released in groups. DASS automatically releases flares at the right moment, changing the release sequence each time to prevent the enemy missile from recognising the patterns.

### THREAT WARNING INDICATORS

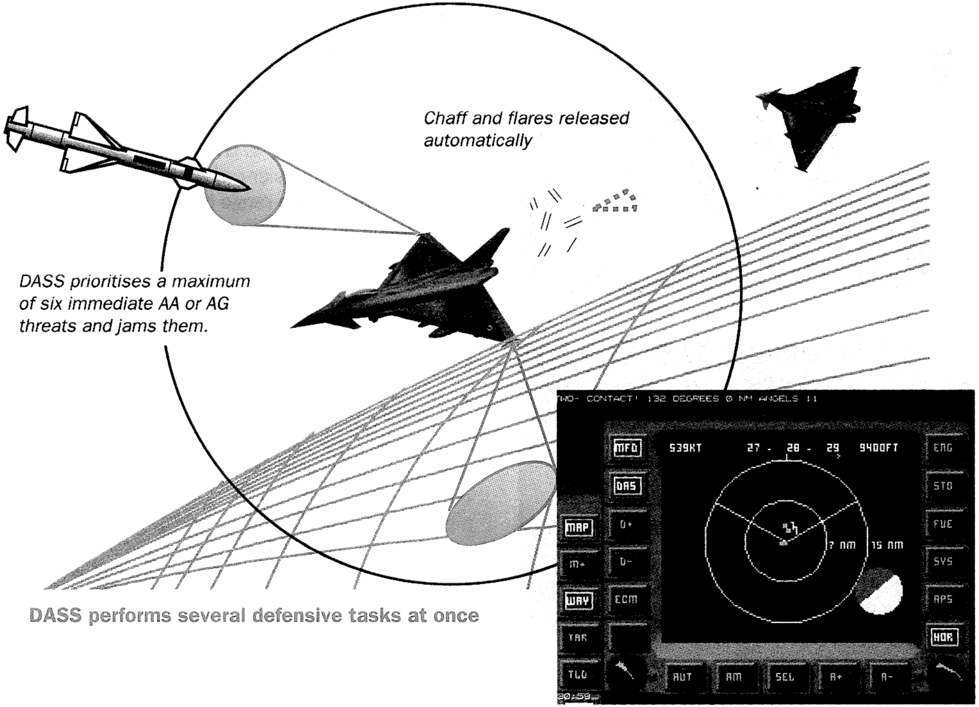
Radar Warning Receivers (RWR) are as old as radar itself, and were developed to tell a pilot when an enemy radar was 'painting' his plane. Signals are gathered from aerials positioned in various parts of the aircraft to give all-round coverage. Modern receivers, such as the type built into the DASS, are able to check 'spikes' against a library of known signals, and decide what aircraft, SAM or EW radar is painting the plane. They can also detect incoming missiles, and trigger an appropriate warning.

In the EF2000, the RWR is supplemented by an IR Warning which uses data from the Infra Red Search and Track System. This is able to detect the hot gases of SAMs and AA missiles in the forward field of view and classify whether it is an IR or radar guided weapon.

# EF2000 AVIONICS

## THE DASS IN USE

The DASS display works like a 2D plan radar with your plane at the centre. However, unlike radar it receives signals passively and only displays ground-based mobiles, ground stations, ships or planes that are 'painting' your aircraft with radar. Aerials in the carbon-fibre skin of the EF2000 detect the direction of a signal and its strength. Because a contact (spike) could be a powerful radar at long-range, or a weak radar at short range, the RWR is inherently poor at giving accurate range data. For this reason, blips tend to move in large steps, rather than smoothly, giving only approximate range data. However, in EuroFighter, the systems engineers have overlaid data from radar and IRST in front of the plane, to provide a much more accurate assessment of objects moving ahead of the plane. This is marked on the MFD as a cone forward of the aircraft.



*Chaff and flares released automatically*

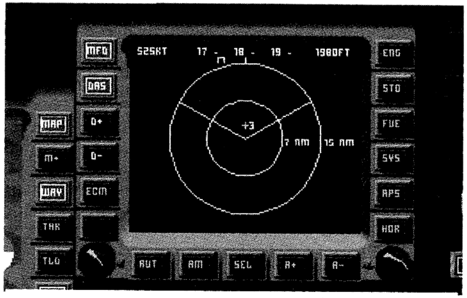
*DASS prioritises a maximum of six immediate AA or AG threats and jams them.*

TWO- CONTACT! 132 DEGREES 0 NM ANGELS 11

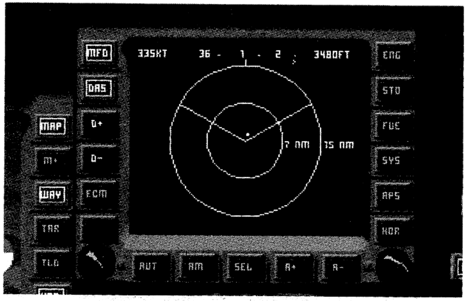
DASS performs several defensive tasks at once

# EF2000 AVIONICS

## THE DASS IN USE


MFD
DAS
MAP
D+
M+
D-
WAY
ECM
TAR
TLG
525KT
17 - 18 - 19 -
1980FT
+3
7 nm
15 nm
ENG
STO
FUE
SYS
APS
HOR
AUT
AM
SEL
A+
A-

Radar missiles are tracked by DASS


MFD
DAS
MAP
D+
M+
D-
WAY
ECM
TAR
TLG
335KT
36 - 1 - 2
3480FT
7 nm
15 nm
ENG
STO
FUE
SYS
APS
HOR
AUT
AM
SEL
A+
A-

DASS also jams the SAMS

### DASS RANGES

Because DASS is fed by a new generation of RWR sensors, IRST, and the ECR-90 radar, it has a very good range for a single-seat aircraft system. Maximum useful range is 80 miles, which makes it effective in BVR combat against aircraft, and allows easier navigation of SAM saturated territory. The range can be stepped up or down using an MFD key.

### A BRIEF HISTORY OF THE DEFENSIVE AIDS SUBSYSTEM (DASS)

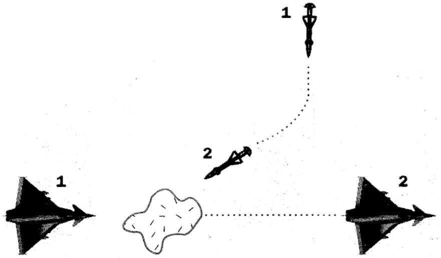
EuroFighter's Defensive Aids SubSystem (DASS) represents the pinnacle of achievement in electronic warfare for single-seat fighter aircraft. It integrates key defensive components into an electronic warfare suite, including radar warning receiver, ECM, offboard decoy (towed), computer, chaff/flare dispenser, laser warner and missile approach warner. A consortium of companies from the United Kingdom and Italy are responsible for its development.
The laser warning system was developed by a UK avionics firm.

## THE DASS IN USE

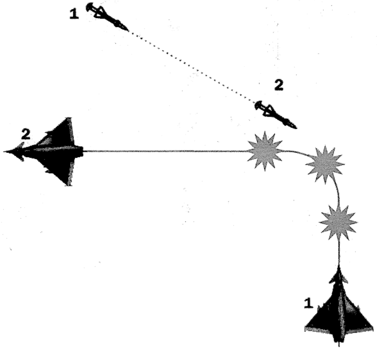
The DASS is displayed on a colour MFD, so it's much easier to distinguish threats. To avoid confusion, it uses the same type of symbology as the ECR-90 radar for air threats, but uses red crosses to portray ground based threats. Small yellow squares represent incoming radar guided missiles, and small red squares show IR missiles in the forward field of view only. Code numbers identify the type of aircraft or system that's tracking you. See the table for details. Threats which have been jammed will flash on and off.

### CHAFF AND FLARE RELEASE

If DASS detects a missile launch, it will release chaff or flare when the missile is within five miles of the plane. However, study the DASS display or 'padlock' view the missile to determine where it is coming from. Study the diagrams for ideal evasive manoeuvres.



Releasing chaff

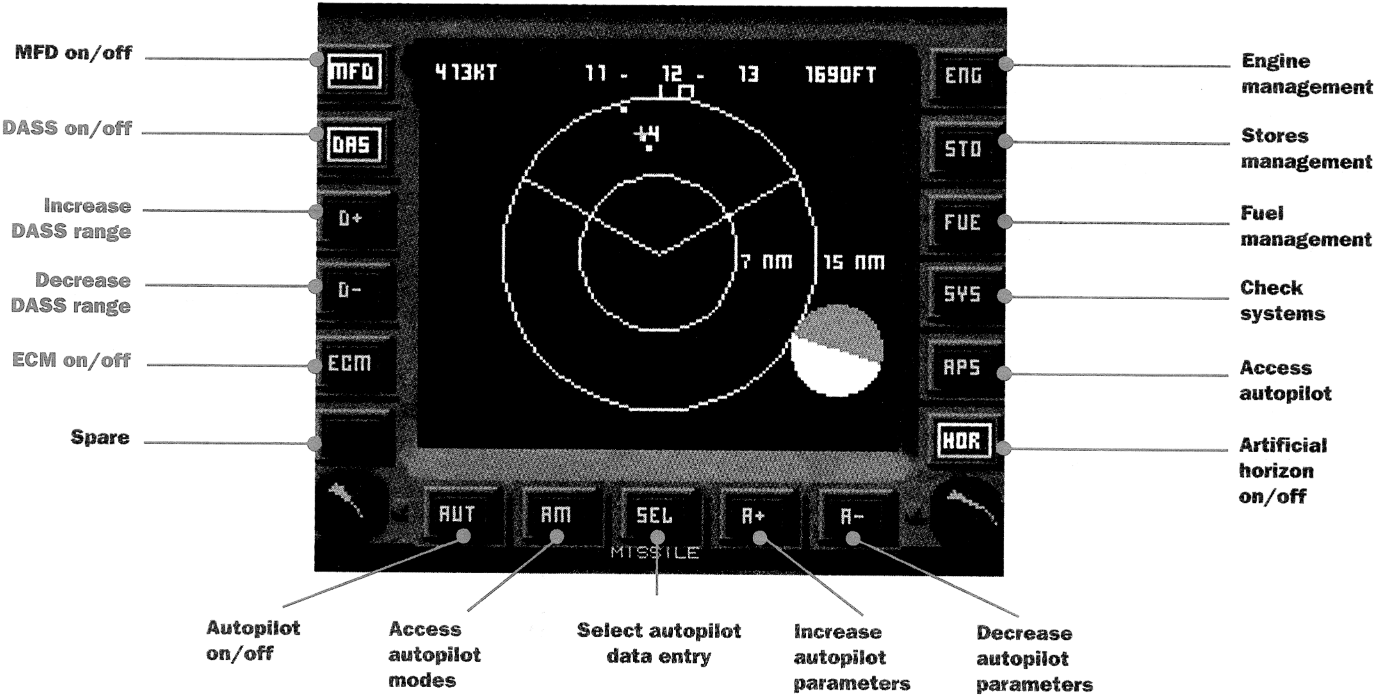


Releasing flares

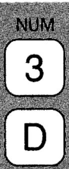
| | |
|---|---|
| **1** | **MiG-29, MiG-31, Su-27, Su-33, Su-35** |
| **2** | **Su-34, MiG-27, MiG-21** |
| **3** | **SAM site** |
| **4** | **Ship based radar** |
| **5** | **Early Warning ground-based long-range station** |
| **6** | **AWACS** |

DASS code numbers for threats

## OPERATING THE DASS


MFD on/off
DASS on/off
Increase DASS range
Decrease DASS range
ECM on/off
Spare
Engine management
Stores management
Fuel management
Check systems
Access autopilot
Artificial horizon on/off
Autopilot on/off
Access autopilot modes
Select autopilot data entry
Increase autopilot parameters
Decrease autopilot parameters
MFD
DAS
D+
D-
ECM
ENG
STO
FUE
SYS
APS
HOR
AUT
AM
SEL
A+
A-
413KT
11 - 12 - 13
1690FT
7 nm
15 nm
MISSILE

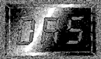
## THE DASS IN USE



### ACCESS THE CORRECT MFD

*PRESS '3' ON THE NUMERIC KEYPAD OR PRESS 'D'*

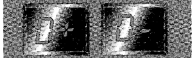
In EF2000, the DASS is displayed on the right-hand Multi-Function Display. Press the appropriate key to access this MFD and press it again to return to the previously selected view.



### SWITCH THE DASS ON/OFF

*PRESS 'DAS' ON THE MFD*

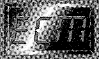
The default is off, but DASS should be on at all times during missions. Selection of other displays will cancel DASS, which may be activated by pressing the appropriate key.



### CHANGE RANGE MANUALLY

*PRESS 'D+' or 'D–' ON THE MFD*

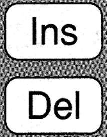
This will allow you to zoom in on the threat picture from the maximum range of 80 miles; remember, the most dangerous radius of threat is 30 miles. When nearby threats are overlaid, zooming-in should help to separate the signals.



### ACTIVATE AND DE-ACTIVATE ECM

*PRESS 'ECM' ON THE MFD*

Automatic systems are wonderful, but they can always let you down. For example, imagine you are making a sneaky, attack run, and the radar of your wingman causes the system to start dumping flares and chaff. Use the ECM key to disable the automatic Electronic Counter Measures when making sneak attacks.



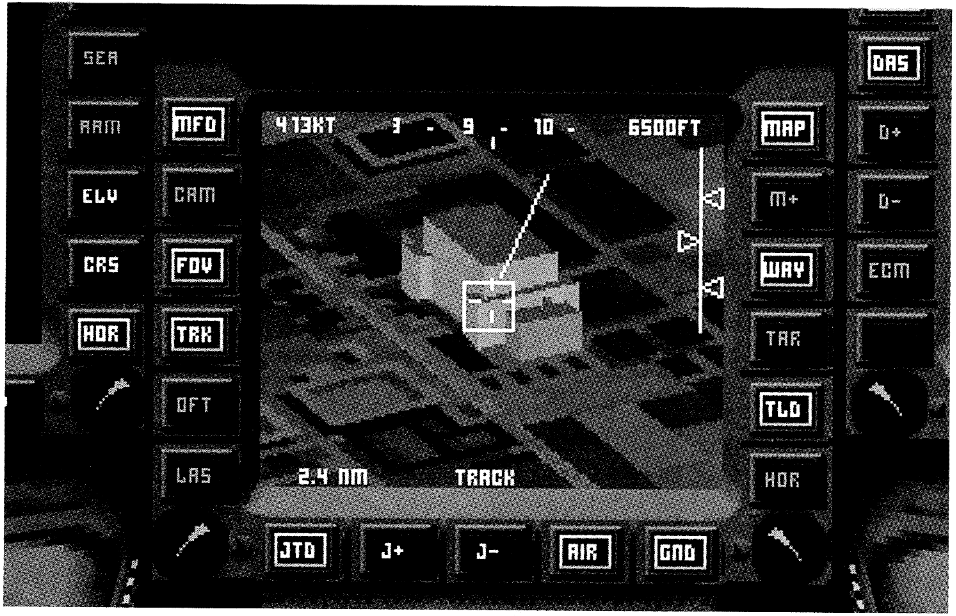
### RELEASE CHAFF AND FLARE MANUALLY

*PRESS 'INSERT' OR 'DELETE' KEYS*

You may feel the need to dump chaff and flare manually, in which case press the appropriate keys.

# EF2000 AVIONICS

## AN INTRODUCTION TO THERMAL IMAGING AND LASER DESIGNATION (TIALD)



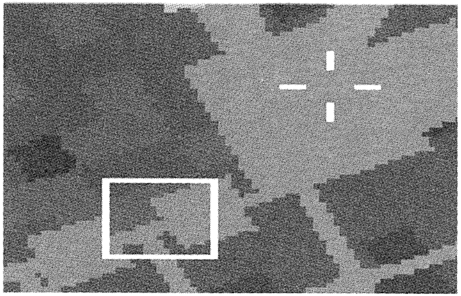
**The TIALD system**

In order to guide an LGB, the target must be designated by a laser for the duration of the attack. In the early days the RAF used the Buccaneer aircraft fitted with a Pavespike laser designation pod to designate targets. The Pavespike pod was one of the first laser designation systems; it was not automatic and consequently required considerable skill from the navigator to ensure a successful attack. The latest version of designation pods is the TIALD which was rushed into service on the Tornado for the Gulf war. TIALD combines the laser with a thermal imaging system which enables the pod to operate at night. In addition, the TIALD pod is fitted with a low light TV sensor which can be used when the thermal contrast is poor (after heavy rain showers). Once the target has been identified, TIALD can automatically track the target using a video correlation tracker. Laser energy is attenuated by cloud and therefore the system requires a clear line of sight to the target to be effective.

## TIALD IN USE

An airborne designator can either designate for its own weapons or can designate for a succession of 'bomb trucks' thus being able to attack many targets on one sortie.
The designator on the attacking aircraft can fly either at high or low levels depending on the defensive threat.

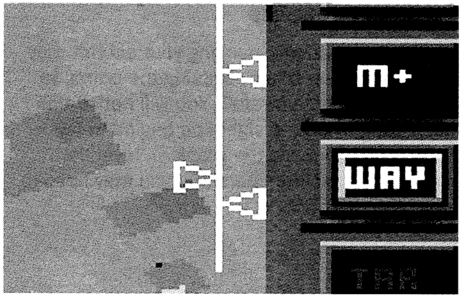
In some cases targets can be designated by ground lasers fired by specially trained ground forces. Whilst very effective, ground based lasers require close coordination and cannot be simply switched to a new target.



Offset aiming

TIALD was developed for use in 2 seat aircraft where the pilot flew and the navigator designated the target. As a result of an urgent operational requirement in 1994 the TIALD pod has been integrated with advanced avionics in the RAF single seat Jaguar to allow effective single pilot operation.

The TIALD system in EF2000 is a derivative of the TIALD training system developed for the RAF by DID. The system gives an excellent insight into some of the difficulties of designating for an LGB attack.



The countdown indicator (left triangle)

### BASIC TARGETING

Run in towards the target at around 15,000 ft. When you select LGBs, the TIALD display is set up on MFD 2. The TIALD pod automatically looks at the Target area. At the centre of the screen are the cross hairs and the tracking box which can be steered with the SHIFT CURSOR ARROW keys to refine the aim position. It is possible to double the magnification, or field of view with the FOV MFD button.

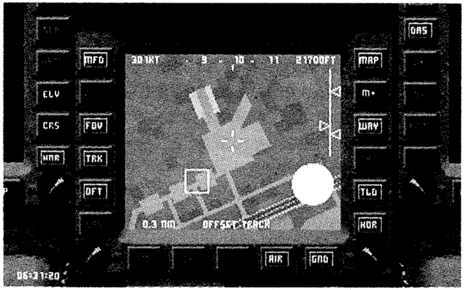
The vertical scale on the right of the display is a countdown scale and indicator for weapon release. You should begin your run two to three minutes from the target, or approximately 15 miles away. Check your moving map display for this information, or read the range data waypoint information. The dotted line extending from the track box indicates the relative bearing of the target, and you should aim to get this at twelve o'clock by flying towards the waypoint. As you get closer, this line will shorten, and it will flash until the target is tracked.

## TIALD IN USE

To 'designate' a target, slew the track box over the target and press the 'TRK' button on the TIALD MFD. Be aware that the image will not necessarily remain stable until you decide to track the target. If you have problems losing your position, turn TIALD on and off again to look at the waypoint once more. If you are happy with the aiming, lase the target by pressing the 'LAS' button on the MFD. When close to the target, TIALD will automatically show the waypoint to look at. You must release the bomb when the countdown indicator is between the triangular markers on the right of the scale. Release after the second triangular marker, also called the 'cliff-edge', will result in a miss. You must now continue to lase the target until you see the bomb impact.

### ADVANCED TARGETING

Occasionally, there will be targets on which it is difficult to make the track box lock, such as a road. The solution is to offset the track box with the 'TIALD OFFSET TRACK' MFD button, and lock it onto any suitable object nearby. You are now free to slew the cross-hairs onto the target, which may be located on the road, and lase it.



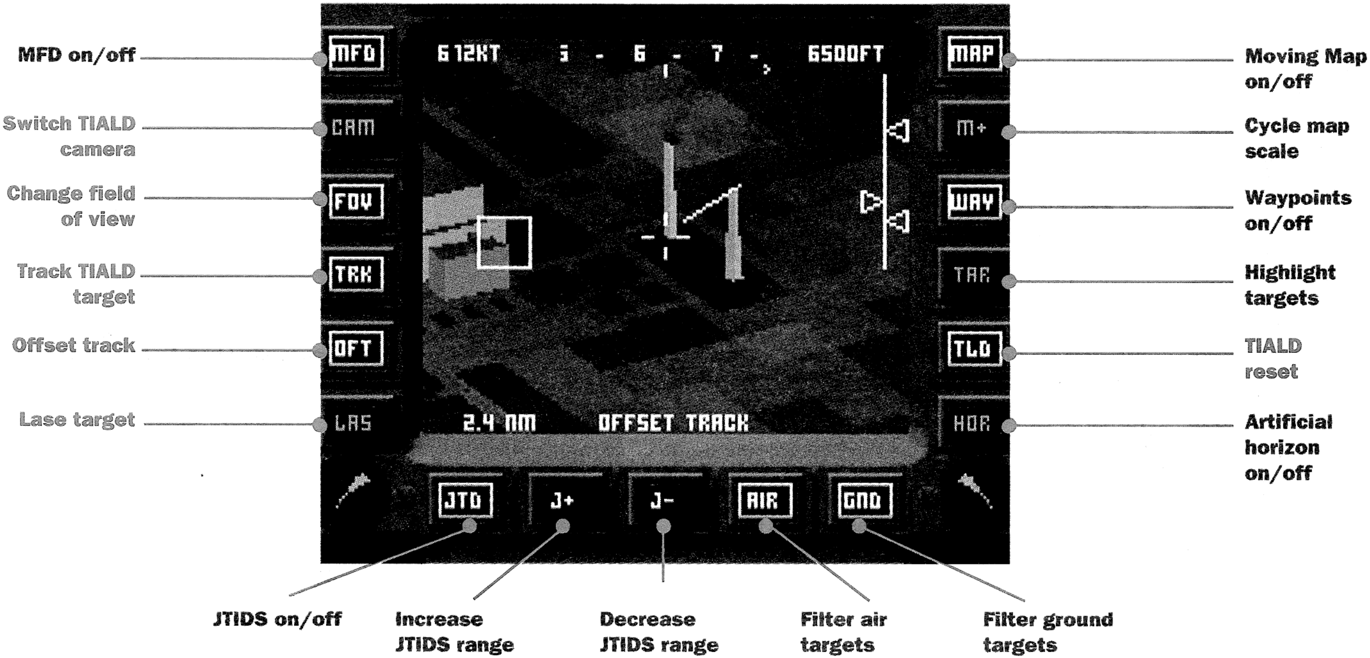
TIALD in action

### MASKING PROBLEMS

In certain situations, banking your aircraft may 'mask' the laser beam, causing the bomb to break lock and go freefall. You will notice this happening when the sight line begins to flash once more. To avoid the problem, level the plane. If the problem persists, you may have to abort the mission.

# EF2000 AVIONICS

## TIALD IN USE


MFD on/off
Switch TIALD camera
Change field of view
Track TIALD target
Offset track
Lase target
MFD
CAM
FOV
TRK
OFT
LAS
612KT
5 - 6 - 7 -
6500FT
2.4 nm
OFFSET TRACK
MAP
M+
WAY
TAR
TLD
HOR
Moving Map on/off
Cycle map scale
Waypoints on/off
Highlight targets
TIALD reset
Artificial horizon on/off
JTD
J+
J-
AIR
GND
JTIDS on/off
Increase JTIDS range
Decrease JTIDS range
Filter air targets
Filter ground targets

# OPERATING TIALD

T

### ACCESSING THE CORRECT MFD

*PRESS KEY 'T'*

In EF2000, TIALD is displayed on the centre MFD. Press the appropriate key to access this MFD.

TLD

### SWITCHING TIALD ON/OFF

*PRESS 'TLD' ON THE MFD*

The default is off, but TIALD is automatically selected when laser guided weapons are chosen.

FOV

### TOGGLE THE FIELD-OF-VIEW

*PRESS KEY 'FOV' KEY ON THE MFD'*

TIALD features a one step zoom focus. When in wide angle field-of-view, the area that corresponds to the zoomed field-of-view is marked

CAM

### CYCLE BETWEEN TV OR INFRA RED CAMERA

*PRESS KEY 'CAM' ON THE MFD*

Select the image which gives the best contrast for your target.

Shift

### SLEW IR OR TV IMAGE.

PRESS 'SHIFT' CURSOR ARROW

Use this to move both the tracker box and the cross hairs.

TRK

### TRACK DESIGNATED AREA.

*PRESS KEY 'TRK' ON THE MFD*

Press this to lock the track box onto a ground object.

LAS

### LASE DESIGNATED AREA.

*PRESS KEY 'LAS' ON THE MFD*

This fires the laser, and triggers the timer countdown.

OFT

### OFFSET TRACK BOX.

*PRESS KEY 'OFT' ON THE MFD*

Disconnects the track box from the cross hairs, allowing you to offset track for easier and more stable aiming.

TLD

### SLAVE TO WAYPOINT.

*TURN TIALD ON AND OFF AGAIN*

Reslaves the TIALD pod to your waypoint view.

Space

①

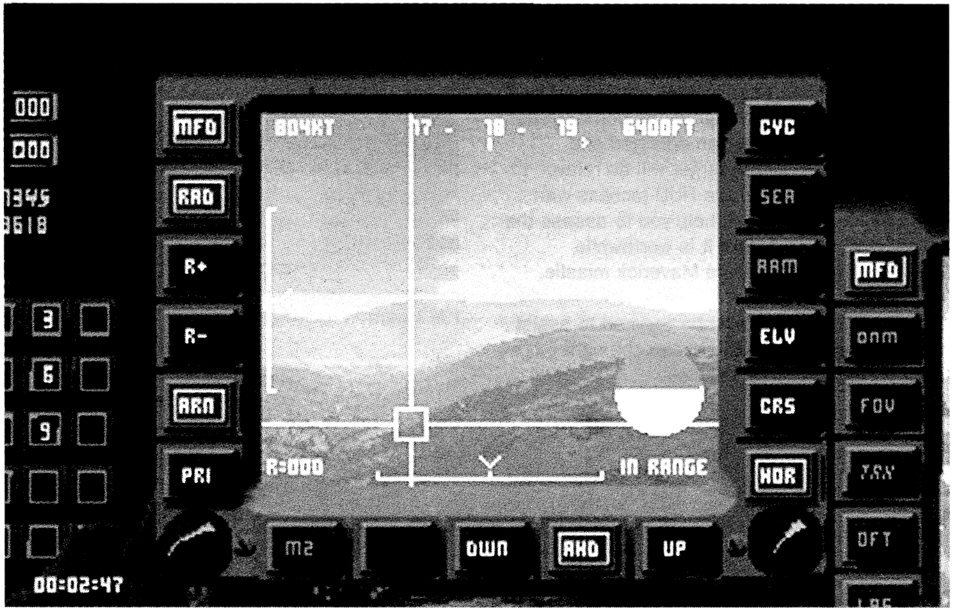
### RELEASE WEAPON.

*SPACEBAR OR JOYSTICK BUTTON 1*

Drops the bomb. Remember that you must lase the target until the bomb hits.

# EF2000 AVIONICS

## AN INTRODUCTION TO THE MAVERICK AIMING SYSTEM


000
000
1345
3618
3
6
9
MFD
RAD
R+
R-
ARN
PRI
804KT
17 - 18 - 19
6400FT
R=000
IN RANGE
CYC
SER
RAM
ELV
CRS
HOR
MFD
ONM
FOV
DFT
M2
DWN
AHD
UP
00:02:47

The Maverick aiming system

The Maverick AGM-65D Imaging Infra Red missile is an ideal weapon for destroying armour, vehicles and aircraft on the ground. Its range of around 12 nautical miles allows the aircraft a limited stand-off margin, enabling it to avoid flying close to the target and possible AAA or SAM fire. To use this weapon to its best effect, practise firing it at long range.

It was not until 1980 that IR detectors were smart enough to detect point targets. The problem is that at great distances, targets subtend an angle that is smaller than the picture element (pixel) of the detector. In EF2000, the IIR detectors are able to detect and lock on the smallest point targets at ranges of around 25 miles. Furthermore, the detector has the ability to analyse two different wavelengths, making it extremely difficult for enemies to use IR camouflage.

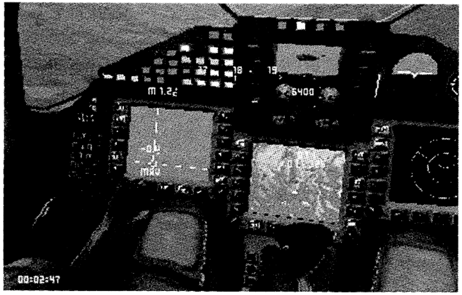
In EF2000, the Maverick aiming system uses both the MFD and IRST screens. The MFD is used for aiming the weapon, and the IRST screen is used for target imaging.

## THE MAVERICK AIMING SYSTEM IN USE

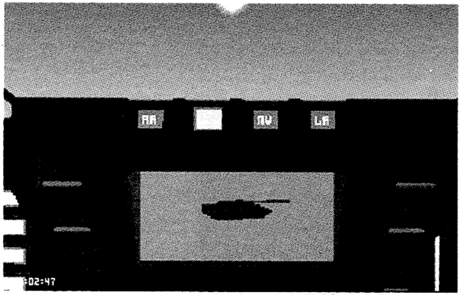
After selection, the weapon is aimed via the left-hand MFD. The image projected on the MFD originates in the missile seeker head, and is slaved to the EF2000 optical systems. Aiming is a straightforward business. Simply fly the plane towards a target, or slew the seeker head with the SHIFT CURSOR keys, and the missile will track the point of greatest temperature differential on the vehicle. Next, the digital centroid seeker adjusts the aim so that the missile is heading directly for the centre of the object. To break the lock, simply slew the seeker head away from the currently selected target, or fly the plane away from the target.

Once a target has been locked, you will receive information on target range in the corner of the MFD. At the same time, an enlarged and enhanced image of the target will be relayed to the IRST screen under the HUD (access with numeric key 5). This will help you to assess the target type, and whether it is worthwhile destroying with a valuable Maverick missile.

If desired, the image may be zoomed to assist target recognition, and help pick the right target from closely bunched vehicles.



Basic targeting



IRST screen under the HUD

## THE MAVERICK AIMING SYSTEM IN USE

### WHEN TO SLEW

Maverick is an ideal weapon for a fast moving jet, which has little time near the target and is vulnerable to ground fire. When terrain hugging and flying directly towards a reported target position, it is best to aim simply by pointing the aircraft at the target, because this is the quickest method. However, when approaching the target on a parallel heading, maintaining a safe distance and slewing the seeker head is your best option. This will allow you to remain at maximum range. Remember, there is a zoom function to help you select the right target.

### AWACS AND FORWARD AIR CONTROL

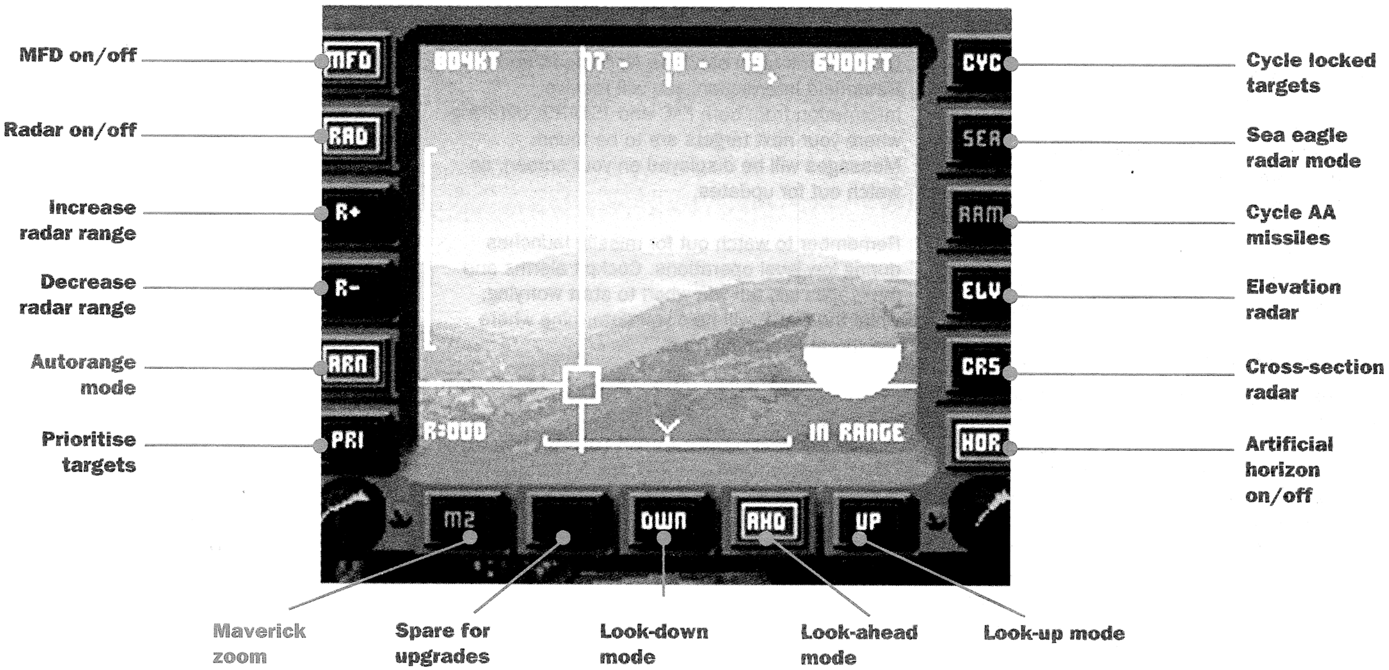
On a real battlefield, little remains the same for very long. The constant movements and redeployment of ground troops and vehicles demands careful and constant monitoring. There are three principle methods of intelligence gathering : special units on the ground, inserted under cover of darkness behind enemy lines by stealthy helicopters; small spotter planes, which act as Forward Air Controllers, relaying tactical information to pilots on the whereabouts and danger of enemy units; and JSTARS, which is able to detect second echelon ground movements deep behind enemy lines.

On missions such as Close Air Support and Battlefield Interdiction, you will receive information from both FAC and JSTARS, detailing where your next targets are to be found. Messages will be displayed on your screen, so watch out for updates.

Remember to watch out for missile launches during low-level operations. Cockpit alarms and messages will tell you when to start worrying, while the DASS will help you determine where the threat is coming from.

# EF2000 AVIONICS

## THE MAVERICK AIMING SYSTEM


MFD on/off
Radar on/off
Increase radar range
Decrease radar range
Autorange mode
Prioritise targets
MFD
RAD
R+
R-
ARN
PRI
804KT
17 - 18 - 19
6400FT
R:000
IN RANGE
CYC
SEA
AAM
ELV
CRS
HOR
Cycle locked targets
Sea eagle radar mode
Cycle AA missiles
Elevation radar
Cross-section radar
Artificial horizon on/off
M2
DWN
AHD
UP
Maverick zoom
Spare for upgrades
Look-down mode
Look-ahead mode
Look-up mode

## AIMING THE MAVERICK

1

Z

Shift

↑ →

Space

①

### ACCESSING THE CORRECT MFD

*PRESS NUM 1*

In EF2000, the Maverick sight is displayed on the left-hand Multi-Function Display. NOTE: Make sure that you have selected the weapons first, otherwise the MFD will display only the radar.

### TOGGLE THE FIELD-OF-VIEW

*PRESS KEY 'Z' ON THE MFD*

Maverick aiming features a one step zoom focus. Press this key once to obtain a close-up imaging, and again to zoom out.

### SLEW MAVERICK IR IMAGE

*PRESS 'SHIFT' CURSOR ARROW*

Use this to move both the tracker box and the cross hairs.

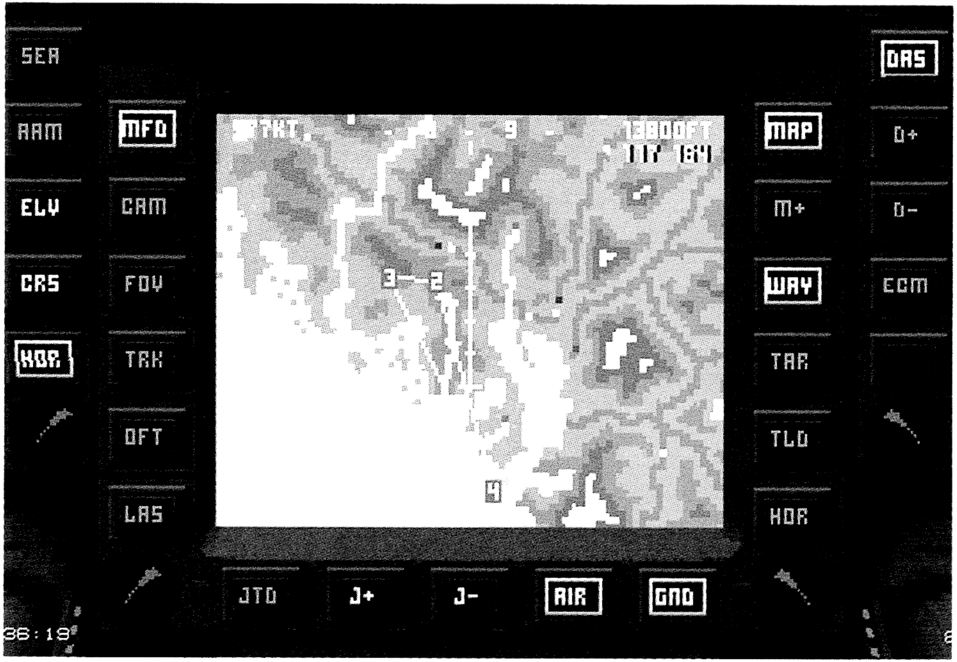
### RELEASE WEAPON

*SPACEBAR OR JOYSTICK BUTTON 1*

Fires the Maverick. Once the Maverick has been fired, look out of the cockpit to check its progress.

# EF2000 AVIONICS

## AN INTRODUCTION TO THE MOVING MAP DISPLAY (MMD)



The electronic version of survey maps

In recent years, digital map technology has played an increasingly important role in navigation and attack planning. Gone are the days when pilots relied on folded ordnance survey maps on their knees. And gone are the days of MMD based on expensive film. Today's MMD is based on data supplied from military-specification data retrieval systems. The advantage of digital data is that they are easy to update, allowing the overlay of tactical information on the display. They also provide the means to replace radar-guided terrain following systems, which are easier for EW operators to detect, and they allow integration of data from other sources, such as JTIDS.

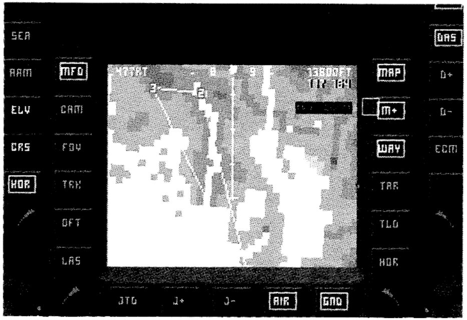
The MMD in EF2000 uses a synthetic map display, and is the principle navigation tool. It will help you follow your waypoints, locate the target and establish your approach, then help you get back to base.

# EF2000 AVIONICS

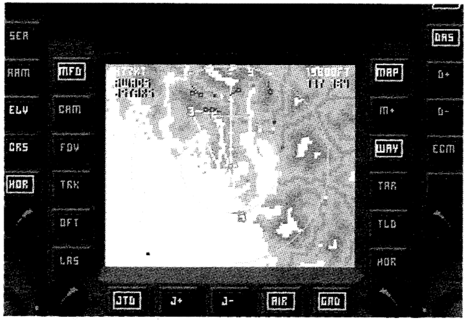
## THE MOVING MAP DISPLAY IN USE

### NAVIGATION WITH THE MMD

The Moving Map Display is located on the centre MFD. The symbol representing your plane is located two-thirds of the way down the display, in order to give you a good forward view. The real EuroFighter offers three different map scales: 500,000:1 map for general navigation and situational awareness; 1000,000:1 for airways flying; and 50,000:1 for target identification and accurate navigation. In EF2000, two maps are available, a larger scale for general navigation; and a smaller scale map for ground attack and precision navigation.


SEA
AAM
ELV
CRS
HOR
MFD
CAM
FOV
TRK
OFT
LAS
13800FT
DAS
MAP
M+
WAY
TRR
TLD
HDR
D+
D-
ECM
JTD
J+
J-
AIR
GND

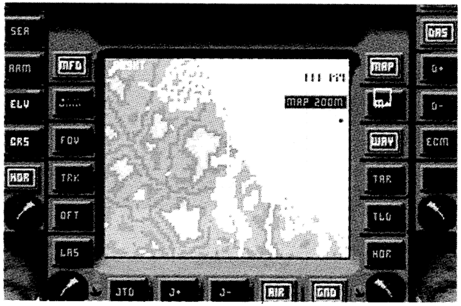
A zoomed map


SEA
AAM
ELV
CRS
HOR
MFD
CAM
FOV
TRK
OFT
LAS
DAS
MAP
M+
WAY
TRR
TLD
HDR
D+
D-
ECM
JTD
J+
J-
AIR
GND

Overlay of JTIDS information

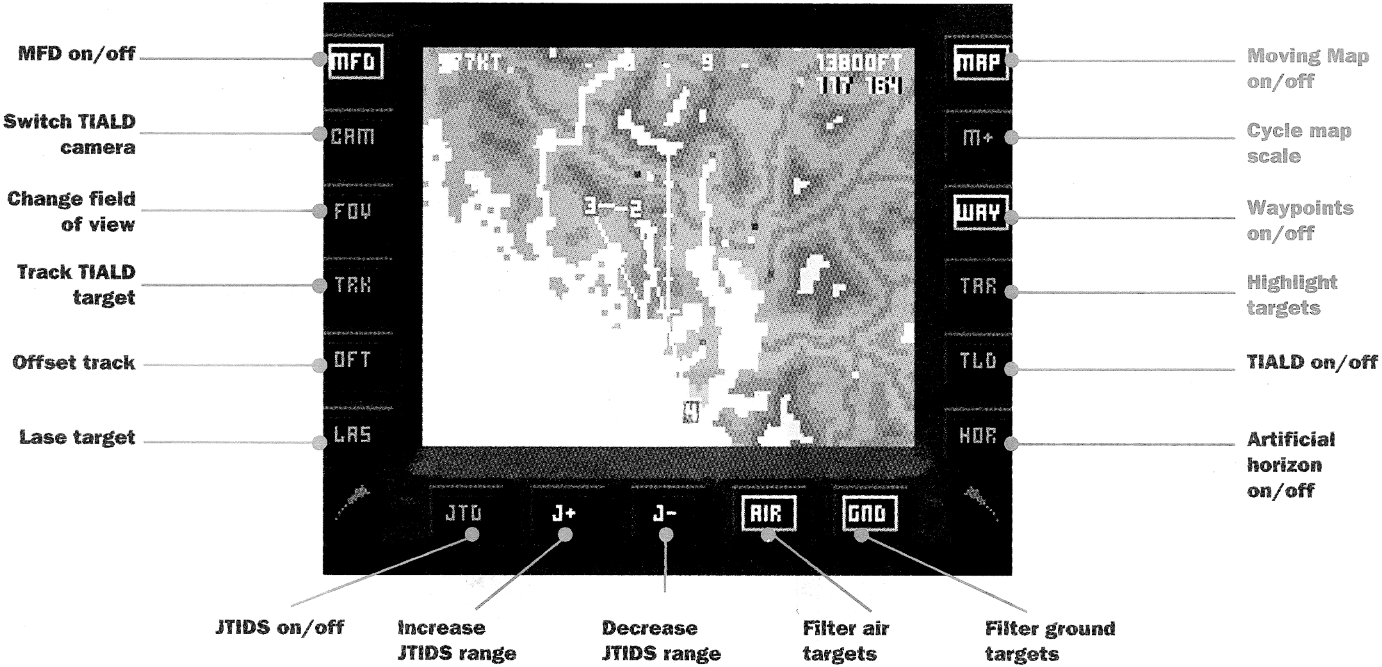
### ESTIMATING TIME TO GO (TTG)

The direction line extending from the top of the MMD is calibrated to show minute intervals. This scale will vary according to your ground speed. So if you want to know how long it will take to reach a point directly in front of you, simply count the number of marks and you have the time! A useful feature of the MMD is the ability to overlay waypoint routes, turning the display into an essential mission tool. It's also possible to overlay JTIDS data, which will indicate the position of hostile aircraft and ground targets.


SEA
AAM
ELV
CRS
HOR
MFD
FOV
TRK
OFT
LAS
MAP ZOOM
DAS
MAP
WAY
TRR
TLD
HDR
D+
D-
ECM
JTD
J+
J-
AIR
GND

Each mark on the white line is 1 minute

## OPERATING THE MOVING MAP DISPLAY


MFD on/off
Switch TIALD camera
Change field of view
Track TIALD target
Offset track
Lase target
MFD
CAM
FOV
TRK
OFT
LAS
Moving Map on/off
Cycle map scale
Waypoints on/off
Highlight targets
TIALD on/off
Artificial horizon on/off
MAP
M+
WAY
TAR
TLD
HOR
JTD
J+
J-
AIR
GND
JTIDS on/off
Increase JTIDS range
Decrease JTIDS range
Filter air targets
Filter ground targets
13800FT

## OPERATING THE MOVING MAP

NUM
2

### ACCESSING THE CORRECT MFD

PRESS '2' ON THE NUMERIC KEYS
In EF2000, the MMD is displayed on the centre Multi-Function Display. Press the appropriate key to access this MFD.

---

M

### SWITCHING THE MMD ON/OFF

*PRESS 'MAP' ON THE MFD OR THE 'M' KEY*

The default status for this MFD is on, but selection of other displays will cancel the MMD, which may be re-activated by pressing the appropriate key.

---

### CHANGING MAP SCALES

*PRESS 'M+' ON THE MFD*

Selects the large scale or small scale maps.

---

### OVERLAYING WAYPOINTS

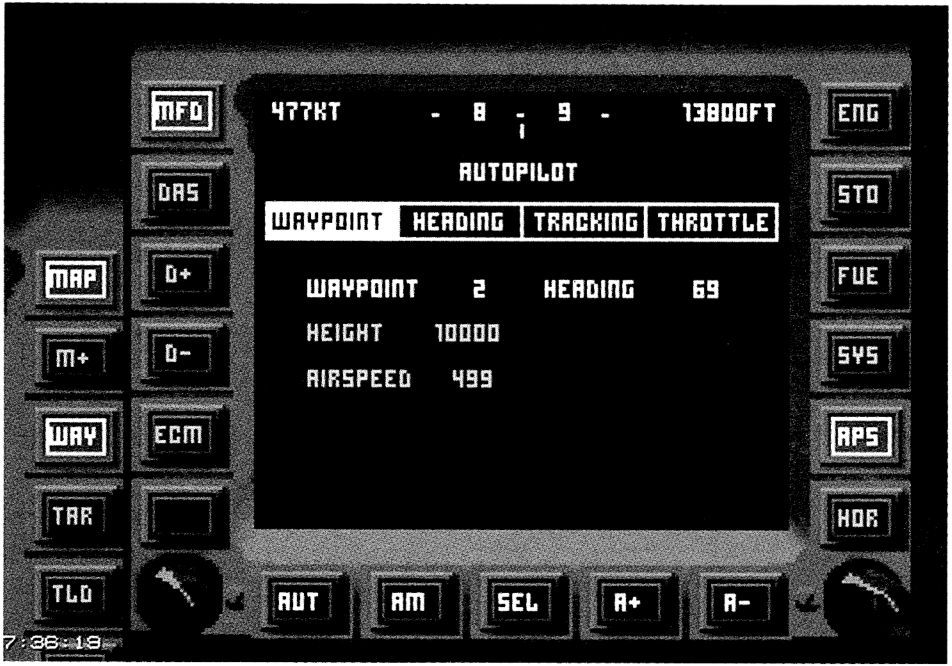
*PRESS 'WAY' ON THE MFD*

Overlays your current mission's waypoint route.

---

# EF2000 AVIONICS

## AN INTRODUCTION TO THE FLIGHT ASSISTANCE SYSTEMS


477KT - 8 - 9 - 13800FT

AUTOPILOT

WAYPOINT 2
HEADING 69
HEIGHT 10000
AIRSPEED 499

When the going gets tough, switch on the autopilot

To say that flying is hard is a myth perpetrated by pilots themselves. To say that flying in the combat environment is easy would be a lie. When battle begins, pilots not only have to monitor the air-situation using a wide variety of sensors, they must command wingmen, monitor and evade missiles, select the appropriate weapons, manoeuvre into the best position, and generally ensure that the aircraft is in a fit state to fight. All of these demands frequently occur in a very short space of time. So it's little wonder that a great deal of research has been invested in helping the pilot fly the plane in high-stress conditions. We have recreated some of these features, which both new and experienced PC pilots will find to their advantage.

Don't feel like it's cheating to use a feature like the Autotracking Autopilot - even the real EF2000 has a very similar system.

# EF2000 AVIONICS

## FLIGHT ASSISTANCE SYSTEMS IN USE

### RECOVERY BUTTON

Key 'L' puts the plane into safe, level flight. It can be pressed just as a pilot begins to black-out due to G-loc, or it can be used to achieve a safe attitude while studying an MFD. The real EuroFighter has a similar button.

### AUTOMATIC LANDING & REFUELING

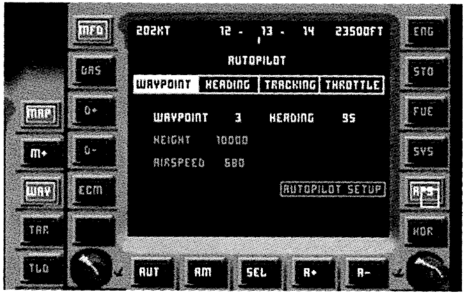
If you don't want to land or refuel yourself, let the plane do it for you. Simply press 'SHIFT S' until you are past the refueller or on the ground again.

### AUTOPILOT

An autopilot system is available on MFD 3, which is able to control the aircraft by adjusting joystick and throttle inputs. There are four main modes, and the pilot simply enters the correct data into the MFD before activating Autopilot.

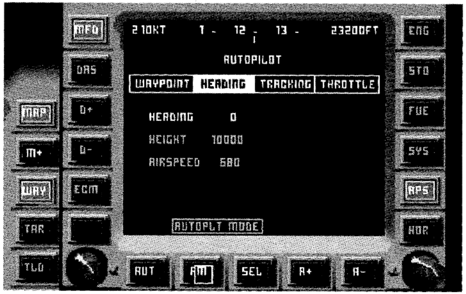
### AUTOPILOT MODE 1: WAYPOINT

Directs your aircraft at the chosen speed to the next waypoint. This is particularly useful if you want to spend some time studying MFDs while on the way to a target.


202KT
23500FT
AUTOPILOT
WAYPOINT 3
HEADING 95
HEIGHT 10000
AIRSPEED 680
12 - 13 - 14
WAYPOINT
HEADING
TRACKING
THROTTLE
AUTOPILOT SETUP
MFD
DAS
D+
D-
ECM
MAP
M+
WAY
TAR
TLD
ENG
STO
FUE
SYS
HOR
AUT
AM
SEL
A+
A-

### AUTOPILOT MODE 2: HEADING

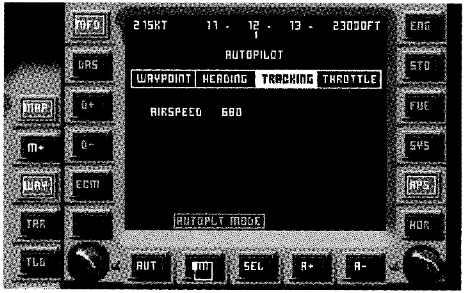
Maintains the required heading, altitude and speed.


210KT
23200FT
AUTOPILOT
HEADING 0
HEIGHT 10000
AIRSPEED 680
1 - 12 - 13 -
WAYPOINT
HEADING
TRACKING
THROTTLE
AUTOPLT MODE
MFD
DAS
D+
D-
ECM
MAP
M+
WAY
TAR
TLD
ENG
STO
FUE
SYS
APS
HOR
AUT
AM
SEL
A+
A-

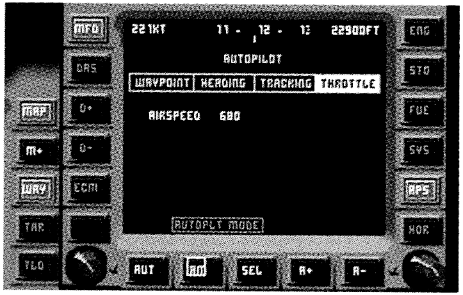
### AUTOPILOT MODE 3: TRACKING

Directs your aircraft towards the aircraft you are tracking on radar. The default speed is the aircraft's own, but adjustments can be made. When it's difficult to get a good angle on a target aircraft, switch to this mode.

In the real EF2000, there is a similar feature which flies the plane into optimum position for weapons firing. With the autofiring cannon, you are using what is know as the Manoeuvring Attack System. To change targets, simply use the target cycle controls on the radar.


215KT
23000FT
AUTOPILOT
AIRSPEED 680
11 - 12 - 13 -
WAYPOINT
HEADING
TRACKING
THROTTLE
AUTOPLT MODE
MFD
DAS
D+
D-
ECM
MAP
M+
WAY
TAR
TLD
ENG
STO
FUE
SYS
APS
HOR
AUT
SEL
A+
A-

## FLIGHT ASSISTANCE SYSTEMS IN USE


221KT
11 · 12 · 1:
22900FT
AUTOPILOT
WAYPOINT
HEADING
TRACKING
THROTTLE
AUTOPLT MODE
MFD
DAS
D+
D-
ECM
MAP
M+
WAY
TAR
TLD
ENG
STO
FUE
SYS
APS
HOR
AUT
AM
SEL
A+
A-

AIRSPEED 680

### AUTOPILOT MODE 4: AUTO-THROTTLE

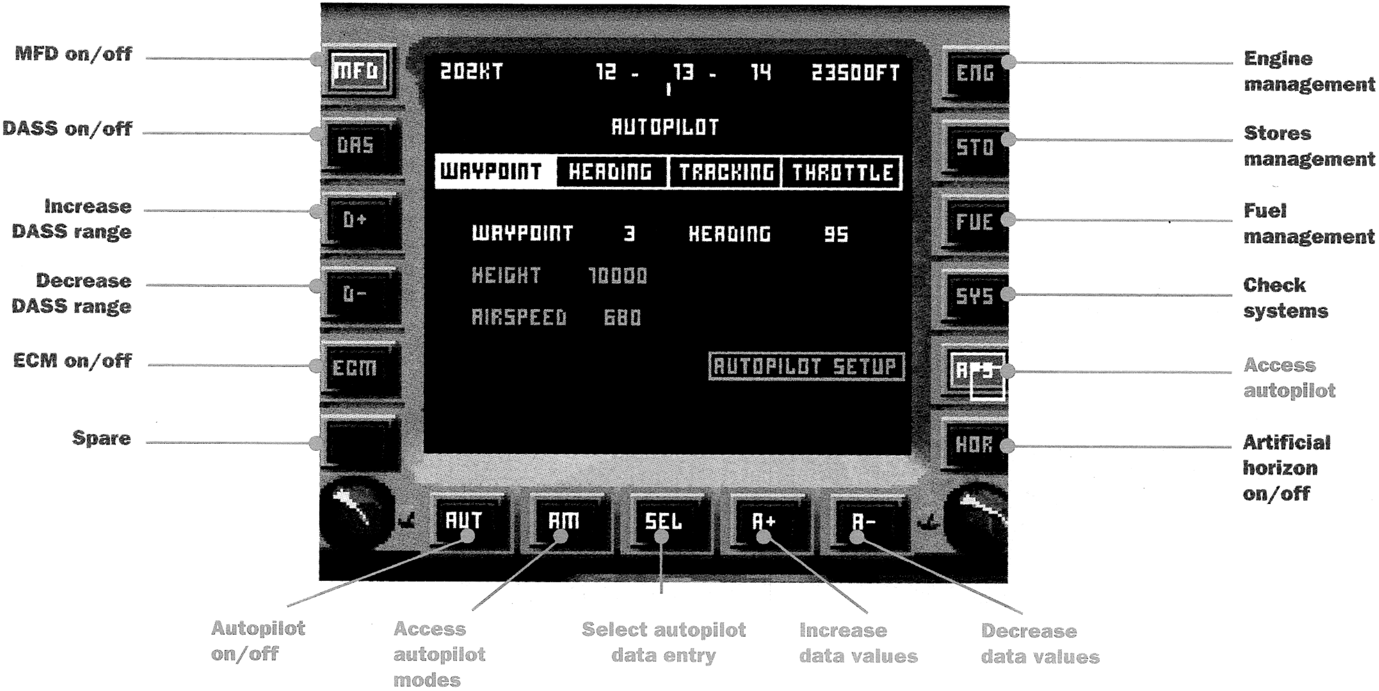
Leaves the joystick (or key) control in the hands of the pilot, but maintains the chosen speed.

This is an excellent mode for maintaining a constant velocity in supersonic BVR manoeuvres. It can also be used to fix a maximum or minimum throttle setting, which may help in dogfighting or landing where constant speed is necessary. For example, with speed set to 250 knots, simply pressing ‘A’ while travelling at Mach 1 using afterburner will cause a sudden bleed-off in speed down to 250 knots.

NOTE: Your aircraft’s speed will not remain constant in all situations, for example, no great speed can be sustained in an 80 degree climb, even on autothrottle.

# EF2000 AVIONICS

## OPERATING THE AUTOPILOT


WAYPOINT 3 HEADING 95

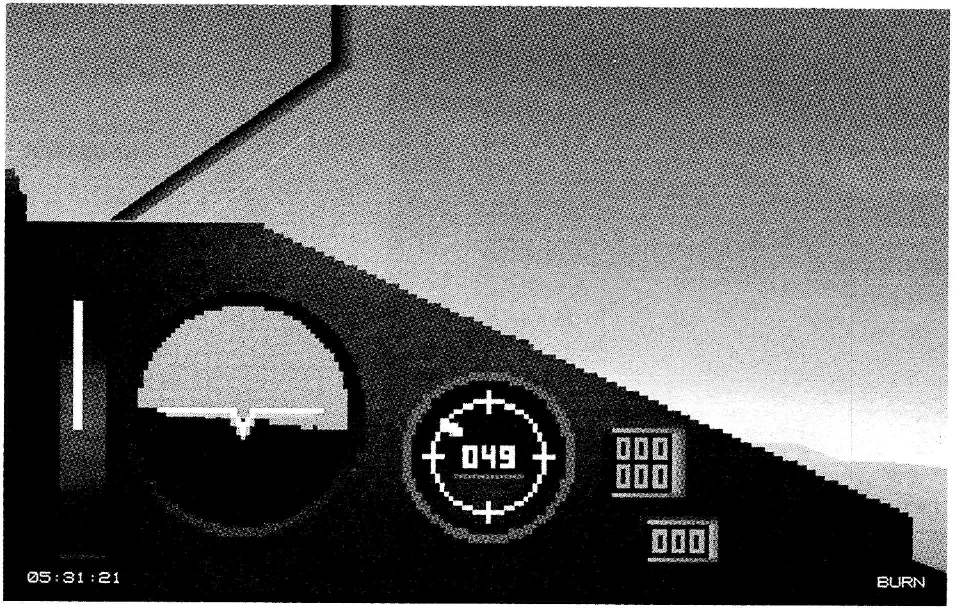
HEIGHT 10000

AIRSPEED 680

202KT
12 - 13 - 14
23500FT
AUTOPILOT
WAYPOINT
HEADING
TRACKING
THROTTLE
AUTOPILOT SETUP
MFD
DAS
D+
D-
ECM
ENG
STO
FUE
SYS
A-S
HOR
AUT
AM
SEL
A+
A-
MFD on/off
DASS on/off
Increase DASS range
Decrease DASS range
ECM on/off
Spare
Engine management
Stores management
Fuel management
Check systems
Access autopilot
Artificial horizon on/off
Autopilot on/off
Access autopilot modes
Select autopilot data entry
Increase data values
Decrease data values

# EF2000 AVIONICS

## ANALOGUE NAVIGATION INSTRUMENTS



The analogue horizon ball and compass

In the worst circumstances, you may lose all your MFD and HUD functions, in which case you will lose all digital navigation data. However, your analogue back-up instruments should still function and will tell you enough for basic navigation. The compass also functions as a basic Horizontal Situation Indicator (HSI), with the red marker showing the heading to the next waypoint, and the green marker indicating your current heading. When both markers are overlaid, you are on course. The read-out in the centre is your current heading in degrees.

# OPERATING THE FLIGHT ASSISTANCE SYSTEMS

L

### RECOVERY BUTTON

*PRESS THE 'L' KEY*

Puts you in straight and level flight when you lose control.

SHIFT

S

### AUTOMATIC LANDING AND REFUELING

*PRESS THE 'SHIFT S' KEYS*

To bypass both events, just use the skip-event feature.

### ACCESS AUTOPILOT SETUP SCREEN

*PRESS 'AU' ON THE MFD*

This key lets you activate the autopilot menu screen.

A

### SWITCH AUTOPILOT ON/OFF

*PRESS 'ON ' ON THE MFD OR PRESS THE 'A' KEY*

Adjust your autopilot parameters, then activate the autopilot from the MFD or the keyboard.

### SELECT AUTOPILOT MODE

*PRESS 'AM' ON THE MFD*

Allows you to select one of four autopilot modes. The mode selected is highlighted in the description bar at the top of the MFD.

### EDIT AUTOPILOT PARAMETERS

*PRESS 'SEL ' ON THE MFD*

Allows you to select a field for editing in any mode. When selected, the field changes colour to green.

### INCREASE AUTOPILOT PARAMETER VALUES

*PRESS 'A+' ON THE MFD*

A single click will increase the value by one unit. Holding the key down will increment the values continuously.

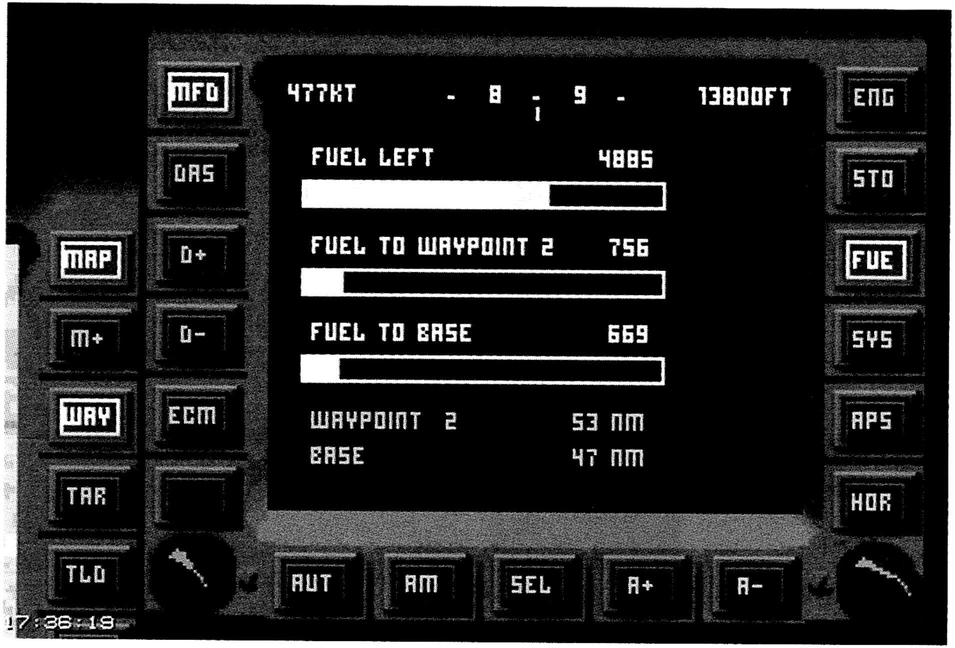
### DECREASE AUTOPILOT PARAMETER VALUES

*PRESS 'A-' ON THE MFD*

A single click will reduce the value by one unit. Holding the key down will decrement the values continuously.

# EF2000 AVIONICS

## AN INTRODUCTION TO THE INFORMATION AND STATUS DISPLAYS



```
477KT      -  8  -  9  -      13800FT
                 1
FUEL LEFT                 4885
FUEL TO WAYPOINT 2         756
FUEL TO BASE               669
WAYPOINT 2               53 NM
BASE                     47 NM
```

The fuel management display

It is in the area of displaying conventional flight and aircraft status information that some of the greatest progress has been made. Of course, there are considerable demands from the civilian sector as well as the military, and this has lead to the development of the 'glass' cockpit. In these modern designs, conventional analogue instruments are replaced by large colour displays, which portray virtual equivalents of the analogue dials and displays. The advantages are not only visual, but ergonomic, because the new systems allow push-button access to more concise information, or data which has been processed for the pilot rather than by the pilot.

In our simulation we have portrayed some of the more critical displays. These include engine management, fuel management, stores management, warning message and briefing displays. These will enable you to assess the airworthiness of your EF2000, or its suitability for action in different scenarios.

# EF2000 AVIONICS

## USING THE INFORMATION AND STATUS DISPLAYS

### ENGINE MANAGEMENT

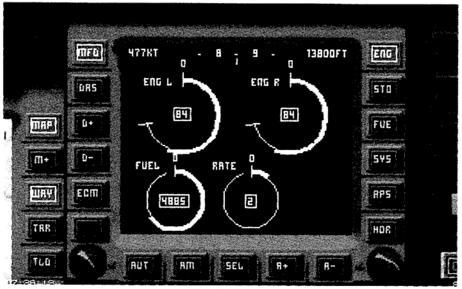
Accessible on the right-hand MFD, this display tells you the status of your engines, your fuel load and the fuel flow for a given throttle setting. Take a look at this display just prior to take-off, to check that all systems are go. It's also useful to check how the afterburner is affecting your fuel load. It will certainly serve to remind you that afterburners should only be used in the following cases:

* To gain altitude rapidly on a ground-launched intercept mission.

* To accelerate rapidly into or away from a dogfight.

* To maximise the range of your long-range missiles prior to launch.

* To assist take-off when fully laden for an Air-to Ground mission.



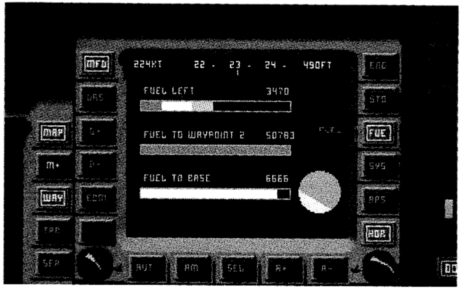
Altitude affects your fuel consumption, so you will be able to use this display to judge the optimum cruising altitude. Use it in conjunction with the fuel management display for proper management of your fuel reserves.

WARNING: USING AFTERBURNER INCREASES YOUR IR SIGNATURE, WHICH MEANS IR GUIDED SAMS AND IRST EQUIPPED AIRCRAFT WILL SEE YOU FOR MILES!

## USING THE INFORMATION AND STATUS DISPLAYS

### FUEL MANAGEMENT

Next to running out of weapons, running out of fuel is a major problem, especially in a dogfight. And dogfighting is certainly sure to burn up fuel at an alarming rate, as you turn, twist, and apply afterburner. The fuel management display is designed to help prevent you falling victim to lack of fuel.



224KT 22 - 23 - 24 - 490FT

FUEL LEFT 3470

FUEL TO WAYPOINT 2 50783

FUEL TO BASE 6666

On its top line, the display shows how much fuel the aircraft is carrying. The bar below shows how much fuel is required to reach the next waypoint. The bottom bar shows how much fuel is required to reach base. If the length of the bottom bars exceeds the length of the bars on top, you are in trouble. Start looking for a tanker or friendly airbase.

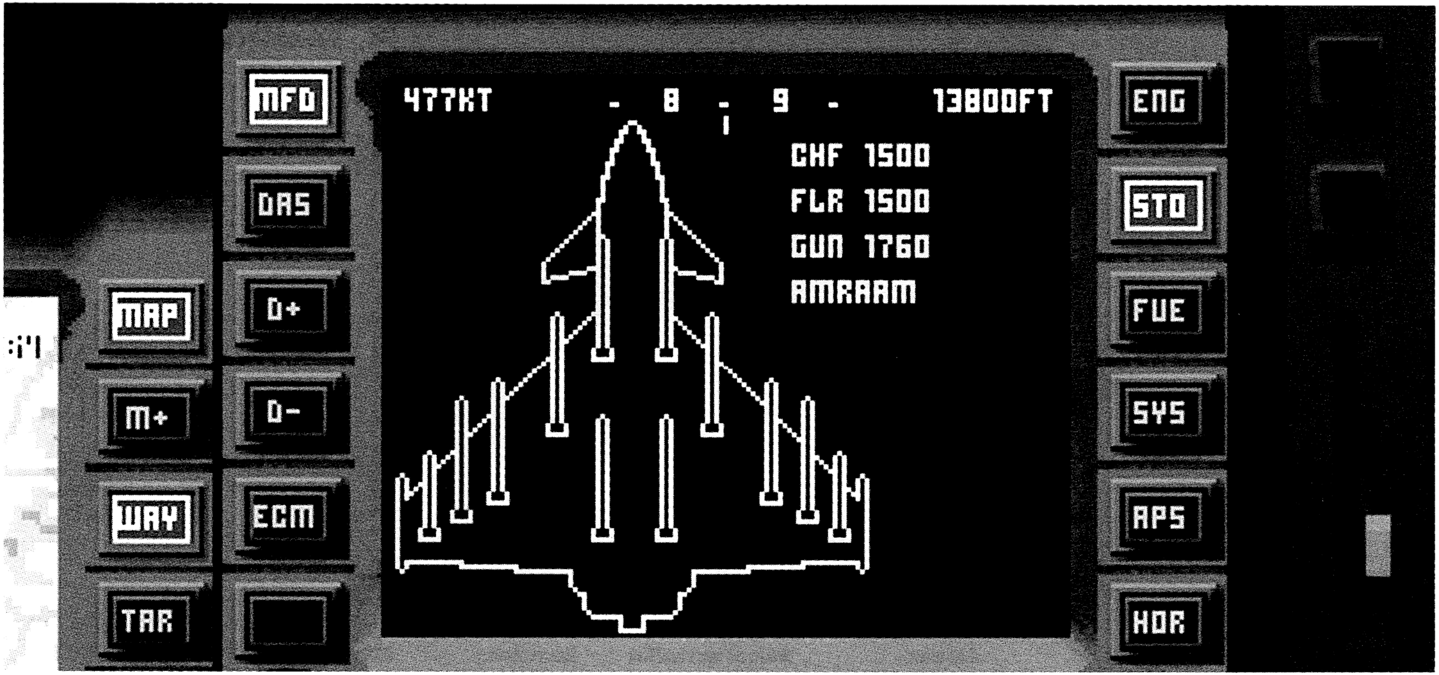
The relationship between throttle setting, duration of reheat or full throttle, and load being carried is critical. It's just the same as a car or motorbike. Don't try high-speed stunts when you're heavy. If you must manoeuvre or depart at high speed, your only choice may be to drop your air to ground stores (Alt J, for Jettison). Although they take valuable pylons, drop-tanks could save you the embarrassment of a dry gas tank. Alternatively, make sure a tanker is on-track at critical phases of your flight, or plan for a refuel stop at a friendly airbase.

Remember, lower the throttle when you're in a dive, as the plane will build momentum. Just remember to open the throttle again before you need to climb. Watch the range indicator on the MFD, and compare this with your distance to target.

On ground attack missions, try to avoid conflicts with fighters altogether. Use stealth. On the run-in, you'll be heavy with weapons and less agile. On the way out, you may be lighter on weapons, but you'll have less gas too, so don't start anything you can't finish. Remember, if you have to dump your AG stores to enter a dogfight, this counts as a 'mission kill' to the enemy (he may not destroy you, but he has eliminated your strike capability).

# EF2000 AVIONICS

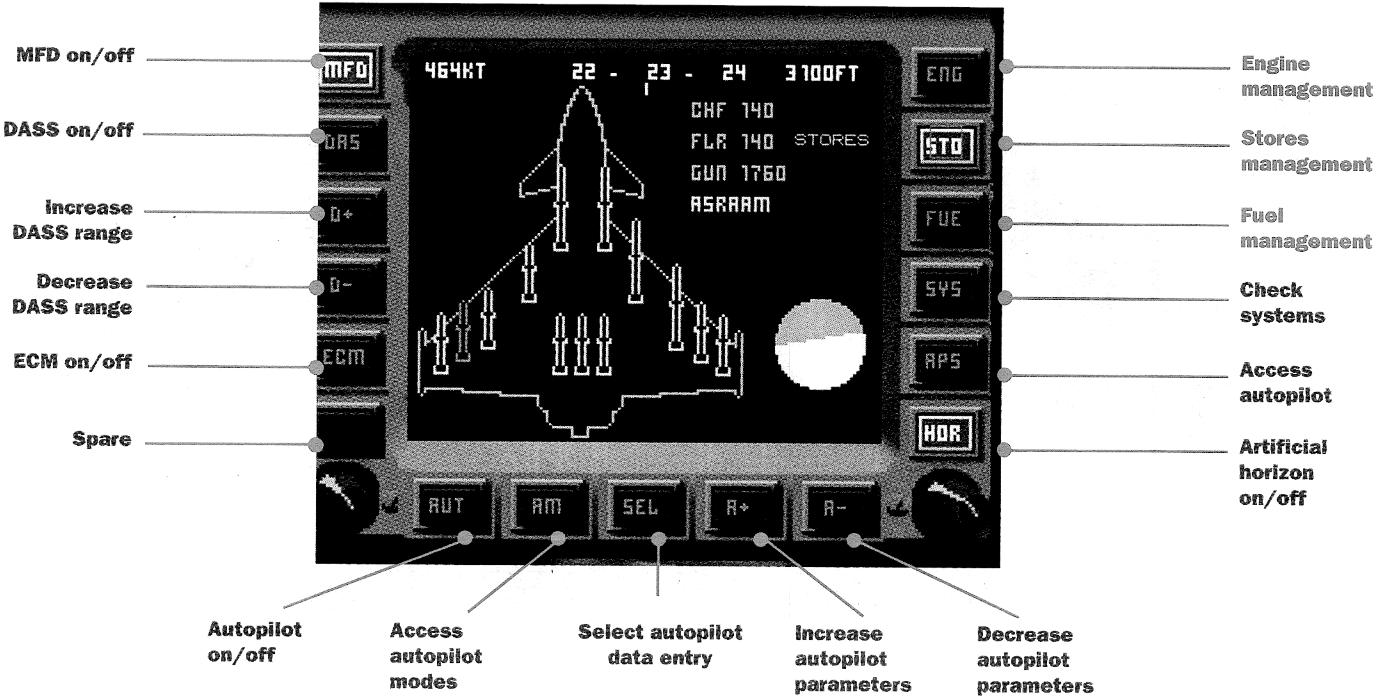
## STORES DISPLAY


MFD
DAS
D+
D-
ECM
MAP
M+
WAY
TAR
477KT
- 8 - 9 -
13800FT
CHF 1500
FLR 1500
GUN 1760
AMRAAM
ENG
STO
FUE
SYS
APS
HOR

This handy graphic shows what's hanging off your pylons and what's not. It's worth keeping an eye on this display.

# EF2000 AVIONICS

## OPERATING THE FLIGHT INFORMATION SYSTEMS


MFD on/off
DASS on/off
Increase DASS range
Decrease DASS range
ECM on/off
Spare
MFD
DAS
D+
D-
ECM
464KT
22 - 23 - 24
3100FT
CHF 140
FLR 140
STORES
GUN 1760
ASRAAM
ENG
STO
FUE
SYS
APS
HOR
AUT
AM
SEL
A+
A-
Engine management
Stores management
Fuel management
Check systems
Access autopilot
Artificial horizon on/off
Autopilot on/off
Access autopilot modes
Select autopilot data entry
Increase autopilot parameters
Decrease autopilot parameters

# OPERATING THE INFORMATION STATUS DISPLAYS

3

### ACCESSING THE CORRECT MFD

*PRESS NUM 3*

All information status displays appear on the right-hand MFD.

### ACCESS THE FUEL MANAGEMENT DISPLAY

*PRESS 'FUE' ON THE MFD*

This gives you access to all fuel management data.

### ACCESS THE ENGINE MANAGEMENT DISPLAY

*PRESS 'ENG' ON THE MFD*

To see the status of the engines and the fuel flow rate, press this key.

### ACCESS THE STORES DISPLAY

*PRESS 'STO' ON THE MFD*

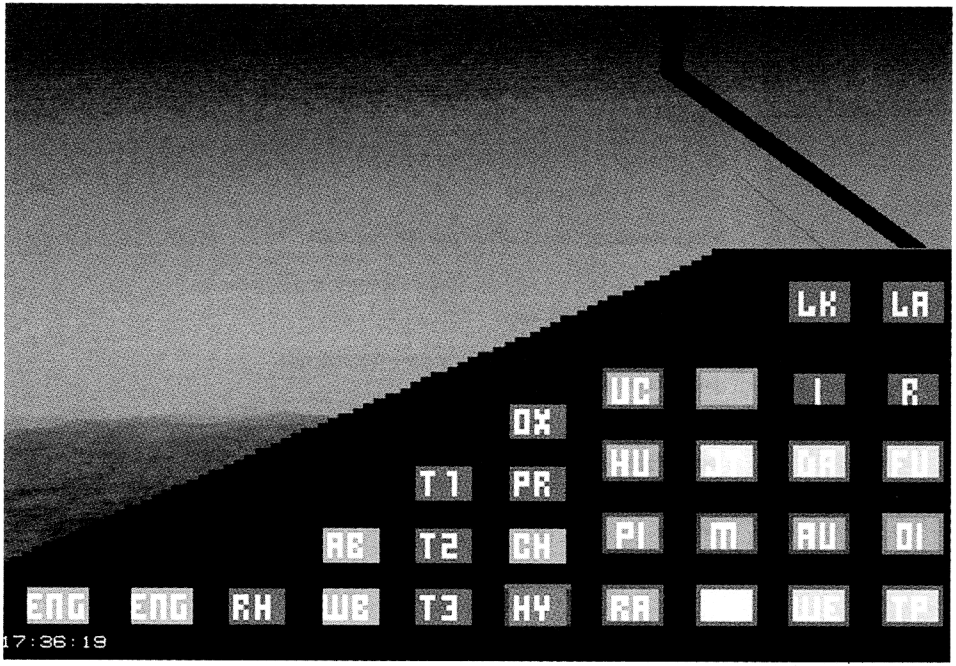
To see what weapons you have and how many, press this key.

# EF2000 AVIONICS

## AN INTRODUCTION TO THE AIRCRAFT WARNING SYSTEMS

In an aeroplane as advanced as EuroFighter, there are many complex systems and a million and one things that could go wrong. Managing the sophistication must never be a challenge for the pilot, who will be busy enough trying to stay alive in the enemy saturated combat environment. This is why EuroFighter incorporates a range of advanced warning and damage control systems.

It is in the cockpit where you notice the biggest difference to previous generations of fighter. To begin with, there are hardly any conventional analog dials or instruments. Instead, there are just three big colour display panels, known as Multi-Function Displays (MFDs), which are capable of displaying a crisp and clear image of all the major avionics systems, even in bright sunlight. There are also a variety of warning lights, in what has now become known as the 'Glass Cockpit'. These lights are arranged into functional groups



The EF2000 warning panel, accessed by the numeric pad '4' key

# EF2000 AVIONICS

## AIRCRAFT WARNING SYSTEMS IN USE

### WARNING LIGHT COLOURS

The cockpit has a simple colour coding system for the information displayed.

**GREEN** The system is functional.

**BLUE** The system is active; i.e. in use.

**YELLOW** Caution! The system has sustained slight damage.

**RED** The system is damaged beyond repair.

### WARNING LIGHT TEXT

| | |
|---|---|
| **ENG** | Engines. |
| **RH** | Reheat or afterburner. This should not be left on for periods longer than two minutes, otherwise the jet-pipe temperature (TP) will become excessive leading to possible engine damage. |
| **AB** | Air brake. When the air brake is extended or retracted, this light will turn blue. Remember to watch your air speed does not become too low with the brake extended. |
| **WB** | Wheel brake. When the wheel brake is activated on the ground, this light will be blue. Use the brakes in bursts, because they may overheat and fail. |
| **T1** | Wing tank 1. Jettison tanks prior to aerial combat or a ground strike. |
| **T2** | Wing tank 2. |
| **T3** | Centreline tank. |
| **OX** | Oxygen. If your oxygen system fails, you must descend to below 10,000 ft, |
| **PR** | Pressure. If your cabin pressure drops, descend to less than 10,000 ft. If both your oxygen and cabin pressure fail at high altitude, land as soon as possible. |
| **CH** | Chute for braking. On activating the chute, the light will turn blue, but the chute should be released (disconnected from the aircraft) at a speed of not less than 50 kts, to prevent excessive damage. Releasing the brake will cause the warning lamp to glow red. |
| **HY** | Hydraulics control many vital systems in the aircraft. Damage to the hydraulic system may cause an explosion, because the fluid is flammable |
| **HU** | Head-Up Display. If the HUD is switched off using the declutter button, the lamp will glow red. |
| **I** | Infra-Red Search and Track System. |
| **R** | Radar. If this system fails, the alternatives are JTIDS and IRST. However, you will be unable to use radar guided weapons. |
| **IR** | IRST failure |
| **UC** | Undercarriage. When the undercarriage is extended or retracted, this light will turn blue. |
| **JT** | JTIDS. Information on the JTIDS display is only available if the relevant AWACS and JSTARS aircraft are flying (AWACS detects AA targets, JSTARS detects ground targets). If the information is not available, the lamp will glow red. |

## AIRCRAFT WARNING SYSTEMS IN USE

| | |
|---|---|
| **M** | Moving Map. Should the MMD fail, you will have to use the paper map included with this manual, and navigate by compass and visual sighting. |
| **NV** | Navigation. Should your HUD fail, you will still have access to the same information on the right-hand glare shield. |
| **DA** | DASS. Failure of the DASS will leave your aircraft vulnerable to attack. You will be forced to drop chaff and flares manually, and the advice is to abort the mission and return to base as quickly as possible. |
| **AU** | Autopilot. Loss of autopilot is an inconvenience, but not critical for a trained pilot. |
| **WE** | Weapons. If weapons become damaged or unusable, jettison them to save weight and return to base as quickly as possible. |
| **FU** | Fuel. If your plane takes damage during combat, check these light quickly to ascertain whether the fuel level has become critical or the supply damaged. |
| **OI** | Oil. Damage to the lubricating systems will eventually lead to damage in the engines, leading to overheating and finally engine failure. If this light is on, try shutting down the damaged engine, prepare for emergency landing or get ready to eject. |
| **TP** | Jet pipe temperature. A warning that your engines are getting too hot, either through excessive use of reheat or through combat damage. |
| **LK** | Missile Lock. If a radar obtains a lock on your plane, this lamp will glow red. |
| **LA** | Missile Launch. If a missile is launched at your plane, this lamp will glow red. |
| **IR** | Indicates an IR missile launch. |
| **RA** | Indicates a radar missile launch. |

# EF2000 AVIONICS

## AIRCRAFT WARNING SYSTEMS ERROR MESSAGES

When a warning lamp turns red, these messages will be displayed automatically on the Warning MFD.

ENG 001 WARNING!

| | |
|---|---|
| RIGHT ENGINE | FIRE |
| THROTTLE | TO ZERO |
| FIRE EXTINGUISHER | ACTIVATED |
| TRANSMIT | MAYDAY CALL |
| LAND | ASAP |
| IF FIRE CONTINUES | EJECT AFTER 30 SECONDS |

ENG 002 WARNING!

| | |
|---|---|
| LEFT ENGINE | FIRE |
| THROTTLE | TO ZERO |
| FIRE EXTINGUISHER | ACTIVATED |
| TRANSMIT | MAYDAY CALL |
| LAND | ASAP |
| IF FIRE CONTINUES | EJECT AFTER 30 SECONDS |

RH 001 WARNING!

| | |
|---|---|
| REHEAT | FIRE |
| THROTTLE | IDLE |
| FIRE EXTINGUISHER | ACTIVATED |
| TRANSMIT | MAYDAY CALL |
| LAND | ASAP |
| IF WARN CONTINUES | STOP ENGINE |
| IF FIRE CONTINUES | EJECT |

RH 002 WARNING!

| | |
|---|---|
| REHEAT | FIRE |
| THROTTLE | IDLE |
| FIRE EXTINGUISHER | ACTIVATED |
| TRANSMIT | MAYDAY CALL |
| LAND | ASAP |
| IF WARN CONTINUES | STOP ENGINE |
| IF FIRE CONTINUES | EJECT |

AB 078 - WARNING!

| | |
|---|---|
| AIR BRAKE | JAMMED |
| TRANSMIT | NOTIFY ATC |
| LAND | SCHEDULED TIME |
| DANGER | FIRE HAZARD DUE TO HYDRAULIC LEAK |

WB 061 - WARNING!

| | |
|---|---|
| WHEEL BRAKE | DAMAGED |
| TRANSMIT | NOTIFY ATC |
| LAND | SCHEDULED TIME |

T 765 - WARNING!

| | |
|---|---|
| WING TANK | FUEL LOSS |
| REHEAT | CANCEL |
| JETTISON | IMMEDIATELY |

T 767 - WARNING!

| | |
|---|---|
| WING TANK | FUEL LOSS |
| REHEAT | CANCEL |
| JETTISON | IMMEDIATELY |

T 768 - WARNING!

| | |
|---|---|
| CENTRE TANK | FUEL LOSS |
| REHEAT | CANCEL |
| JETTISON | IMMEDIATELY |

OX 221 - WARNING!

| | |
|---|---|
| OXYGEN SYSTEM | FAILED |
| EMERGENCY OXYGEN | ACTIVATED |
| ALTITUDE | TO BELOW 10,000 FT |
| LAND | ASAP |

PR 141 - WARNING!

| | |
|---|---|
| CABIN PRESSURE | LOW |
| EMERGENCY OXYGEN | ACTIVATED |
| SPEED | BELOW 300 KTS |
| ALTITUDE | TO BELOW 10,000 FT |
| LAND | ASAP |

CH 190 - WARNING

| | |
|---|---|
| BRAKE CHUTE | DAMAGED |
| LAND | SCHEDULED TIME |

# EF2000 AVIONICS

## AIRCRAFT WARNING SYSTEMS ERROR MESSAGES

HY 002 - WARNING!

| | |
|---|---|
| HYDRAULIC SYSTEM | FAILED |
| CHECK | REFUELLING PROBE |
| CHECK | GEAR |
| CHECK | AIRBRAKE |
| LAND | ASAP DUE TO FIRE RISK |

HU 230 - WARNING!

| | |
|---|---|
| HUD | DAMAGED |
| ACTION | USE ANALOGUE INSTRUMENTS |

PI 121 - WARNING!

| | |
|---|---|
| PIRATE IRST | DAMAGED |
| ACTION | USE RADAR |

RA 124 - WARNING!

| | |
|---|---|
| RADAR | DAMAGED |
| ACTION | SWITCH TO IRST OR JTIDS |

UC 036 - WARNING!

| | |
|---|---|
| UNDERCARRIAGE | DAMAGED |
| JETTISON | ALL WEAPONS EXCESS FUEL |
| LANDING | ATTEMPT SLOW LANDING OR EJECT AFTER MISSION |

JT 089 - WARNING!

| | |
|---|---|
| JTIDS | FAIL |
| ACTION | USE RADAR |

MM 090 - WARNING!

| | |
|---|---|
| MOVING MAP | FAIL |
| ACTION | USE PAPER MAP |

NV 004 - WARNING!

| | |
|---|---|
| NAV HUD | FAIL |
| ACTION | USE ANALOGUE INSTRUMENTS |

DA 331 - WARNING

| | |
|---|---|
| DASS | FAIL |
| ACTION | RETURN TO BASE |

AU 441 - WARNING!

| | |
|---|---|
| AUTOPILOT | FAIL |
| ACTION | DO NOT ENGAGE |

WE 342 - WARNING!

| | |
|---|---|
| WEAPONS | FAIL |
| ACTION | RETURN TO BASE |

FU 120 - WARNING!

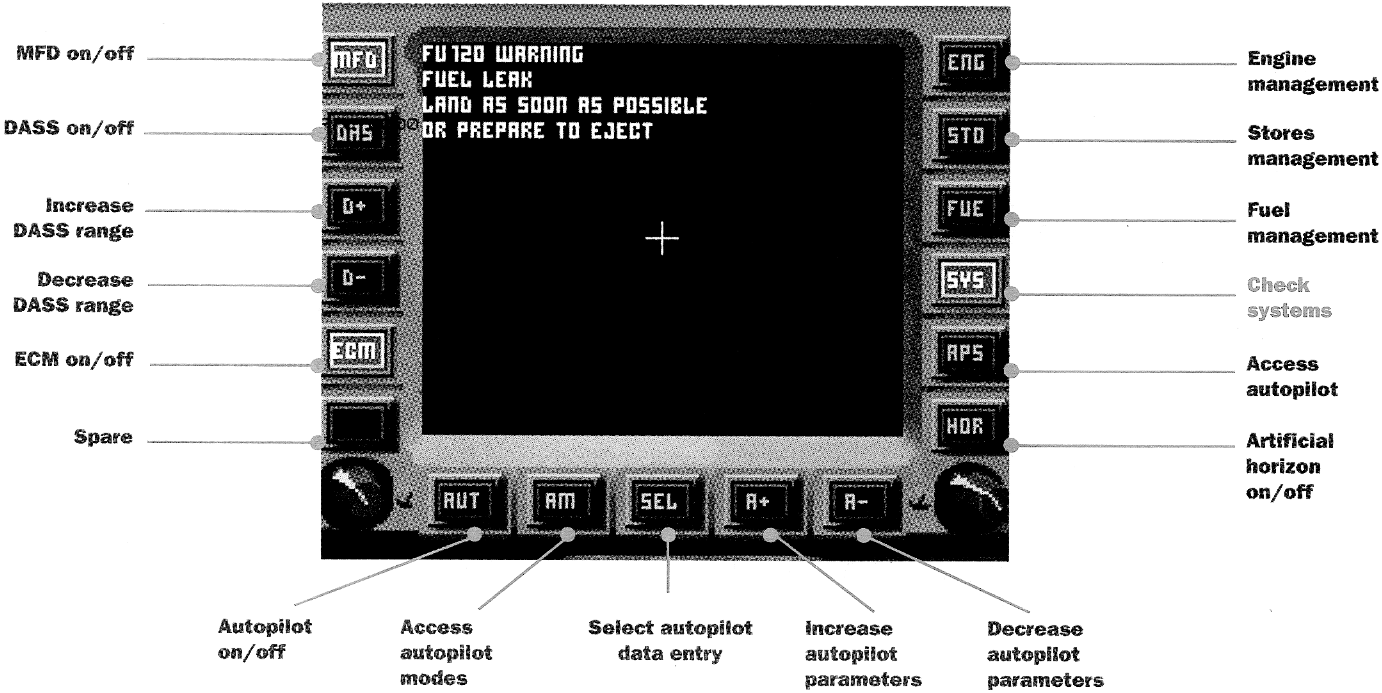
| | |
|---|---|
| FUEL SYSTEM | FUEL LOSS |
| REHEAT | CANCEL |
| LANDING | ASAP OR PREPARE TO EJECT |

TP 002 - WARNING!

| | |
|---|---|
| ENGINE | OVERHEAT |
| REHEAT | CANCEL |
| THROTTLE | TO 70% POWER |

# EF2000 AVIONICS

## OPERATING THE MFD WARNING SYSTEM

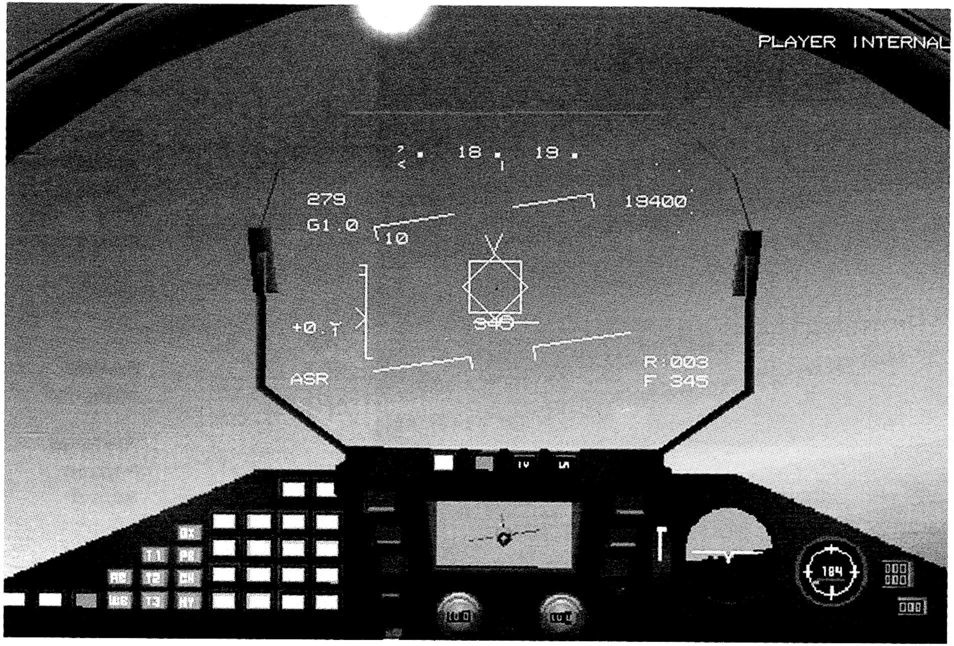


FU 120 WARNING
FUEL LEAK
LAND AS SOON AS POSSIBLE
OR PREPARE TO EJECT

MFD
DAS
D+
D-
ECM
ENG
STO
FUE
SYS
APS
HOR
AUT
AM
SEL
A+
A-
MFD on/off
DASS on/off
Increase DASS range
Decrease DASS range
ECM on/off
Spare
Engine management
Stores management
Fuel management
Check systems
Access autopilot
Artificial horizon on/off
Autopilot on/off
Access autopilot modes
Select autopilot data entry
Increase autopilot parameters
Decrease autopilot parameters

# EF2000 AVIONICS

## AN INTRODUCTION TO THE HUD AND HMD



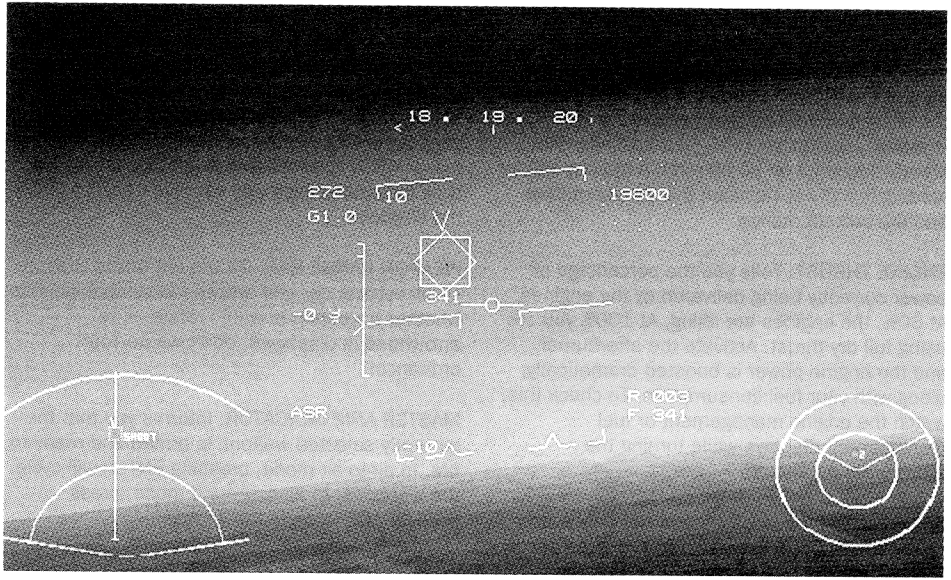
The EF2000 HUD and cockpit

World War II saw the development of the predictor gunsight, which projected a computing gunsight onto a plate of glass between the pilot and the canopy. With the advent of digital computers in post-war avionics, this relatively simple device was to evolve into the Head Up Display (HUD) that is now a standard feature of modern jet fighters. The major difference between the early reflecting gunsights and today's HUD is the amount and type of information displayed.

In EuroFighter, you'll find data on pitch, heading, speed, altitude, gear status, weapons selection and much more. In fact, virtually all you need to know for 90% of the time you are flying is projected onto the HUD. Naturally, HUD design has its own peculiar problems - not least how much information to display without confusing the pilot or causing images to overlap and lose their meaning. For this reason, HUD symbology varies according to the flight mode currently in use; for example, air-to-air combat, refuelling, air-to-ground missions and landing all have their own special modes.

# EF2000 AVIONICS

## AN INTRODUCTION TO THE HUD AND HMD



Helmet mounted sights or displays are a more recent innovation, and show the trend towards integrating information systems into the pilot's helmet. Such displays allow weapons to be launched 'off-boresight', or when the direction of plane travel does not correspond with where the pilot wants to aim. The advantage is obvious: the pilot can now engage targets much more easily with less manoeuvring. In a knife-edge fight, this will make the difference between life and death.

# EF2000 AVIONICS

## AN INTRODUCTION TO THE HUD AND HMD

### INFORMATION COMMON TO ALL HUD MODES

The HUD has four modes: AIR-TO-AIR MODE; AIR-TO-GROUND/NAVIGATION MODE; REFUELLING MODE; and INSTRUMENT LANDING MODE. Although each mode has its own special features, much of the information is common to all. These commonalties are described here.

AIRSPEED: From standstill to Mach one, the speed is shown in knots. At the speed of sound, your velocity is automatically shown as a Mach number. You will notice that the speed of sound is achieved at seemingly lower speeds the higher you fly, simply because there is less air resistance at altitudes.

ALTIMETER: Up to altitudes of 5,000 ft above the nearest terrain, the altimeter displays what is known as RADALT. This simply means that a small downward looking radar calculates your real altitude above the terrain below, as opposed to your altitude above sea level, otherwise known as BAROMETRIC ALTITUDE. Above 5,000 ft, barometric altitude is displayed automatically. The small clock surrounding the altitude data displays your change in altitude in hundreds of feet.

VERTICAL SPEED INDICATOR (VSI): This instrument appears on the AG, landing and refueling HUD, but a back-up is located on the right of the IRST. It shows the vertical speed of the aircraft in units of feet per second. The VSI is mainly used to perform good landings and steady descents on bomb runs. A healthy VSI for landing is halfway between the middle marker and the bottom marker.

ENGINE THRUST: Tells you the percentage of power currently being delivered by the engines. At 60%, the engines are idling. At 100% you are using full dry thrust. Activate the afterburner, and the engine power is boosted dramatically, along with your fuel consumption. To check this, watch the engine management or fuel management displays while turning the afterburner on and off.

G-FORCE: The G-Force indicator not only warns you when G-LOC is likely to occur, it gives you a way to time the rate of your turns. See the section devoted to gravity.

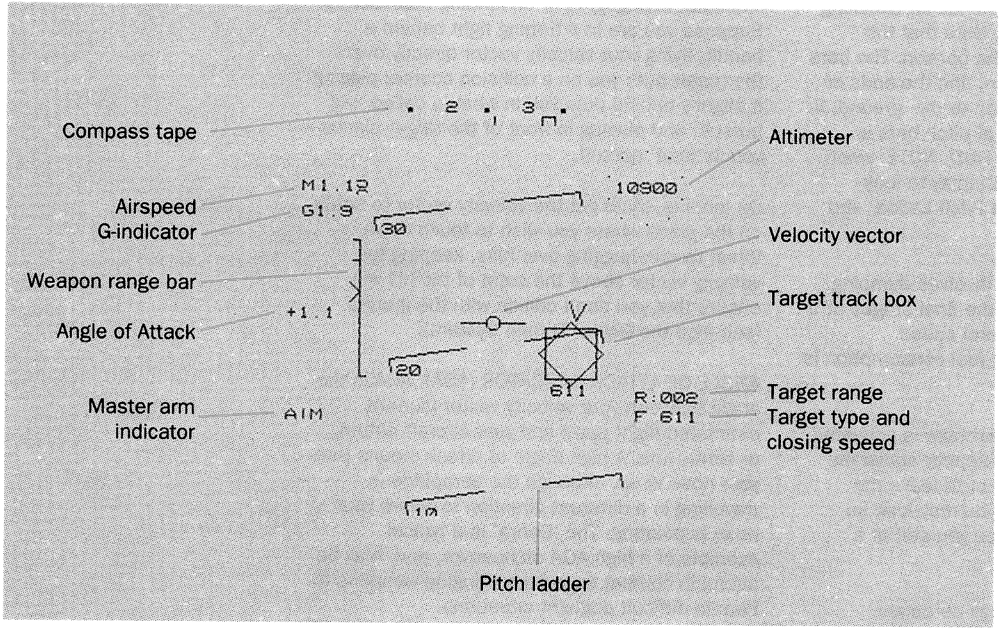
COMPASS TAPE: Located at the top of the HUD, and giving your heading in units of 10 degrees. North is at 0 degrees, East is at 90 degrees, South is at 180 degrees and West is at 270 degrees. To read your heading, check the number above the pipper, which is located just below the tape in the centre. A small inverted 'U' shaped mark indicates the correct heading for your currently selected.waypoint. The small arrow which appears on the left of the compass tape indicates which way you must turn to find the waypoint.

WEAPON RANGE BAR: On the left of the HUD, a small vertical bar and arrowhead symbol indicate whether a weapon is within range. If no arrowhead is displayed, don't waste your ordnance!

MASTER ARM INDICATOR: Informs you that the currently selected weapon is armed and ready to fire. In air-to-air mode, pressing ENTER will cycle the weapons. In air-to-ground mode, press BACKSPACE to cycle the weapons.

# EF2000 AVIONICS

## AN INTRODUCTION TO THE HUD AND HMD


Compass tape
2
3
Altimeter
10900
M1.12
G1.9
Airspeed
G-indicator
30
Velocity vector
Weapon range bar
Target track box
+1.1
Angle of Attack
20
611
R:002
F 611
Target range
Target type and closing speed
Master arm indicator
AIM
10
Pitch ladder

# EF2000 AVIONICS

## AN INTRODUCTION TO THE HUD AND HMD

PITCH LADDER: This is very handy for checking the orientation of the plane. Note that the widest bar corresponds to the horizon. The bars below the horizon are broken, and the ends of the bars indicate the direction to the ground. In air-to-air mode, the number of pitch bars is halved to help declutter the HUD. NOTE: when using the Helmet Mounted Display to look around the aircraft, both the Pitch Ladder and Velocity Vector disappear.

AFTERBURNER: Afterburner involves dumping large quantities of fuel into the final stages of a jet engine. It boosts power and speed considerably, but at a price: fuel consumption is enormous.

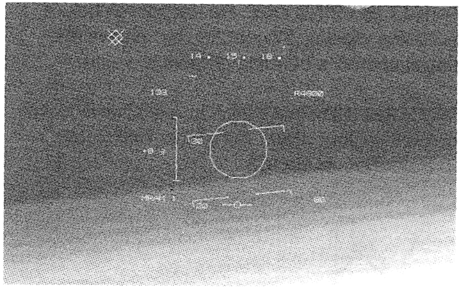
AIRBRAKE: Whenever your airbrake is activated, a small flashing symbol will appear above the velocity vector. Remember not to leave the airbrake on for too long, or you may lose so much airspeed that you place yourself at a tactical disadvantage.

VELOCITY VECTOR: This small aeroplane shaped symbol predicts your flight path, and therefore provides an invaluable aid to positioning yourself for critical manoeuvres; for example, in dogfights or on landing approaches. Suppose you are in a turning fight behind a bandit, flying your velocity vector directly over the target puts you on a collision course; placing it slightly behind puts you in what is called 'lag' pursuit; and placing in front of the target places you in 'lead' pursuit.

On landing, try to get the velocity vector to settle on the place where you wish to touch down. When terrain hugging over hills, keeping the velocity vector above the crest of the hill will ensure that you don't collide with the ground (see also the Digital Terrain System).

ANGLE OF ATTACK INDICATOR (AOA): AOA is the angle between your velocity vector (current estimated flight path) and your aircraft datum, or centre-line. A high angle of attack means that your nose is up, although the aeroplane is travelling in a different direction to where your nose is pointing. The 'Cobra' is a typical example of a high AOA manoeuvre, and may be useful in combat for quickly bringing weapons to bear in difficult dogfight situations.

## AIR-TO-AIR HUD AND HMD MODES



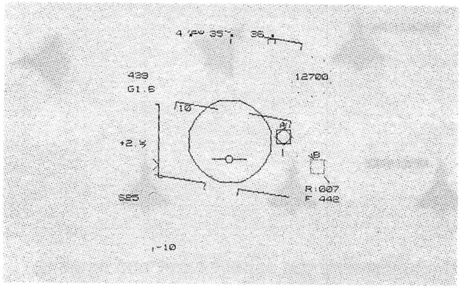
The AA hud mode

When this mode is chosen, the air-to-air radar, JTIDS and DASS are activated, the flight model is adjusted to a more appropriate air-to-air combat profile, and air-to-air missiles can be launched. The HUD symbology becomes combat-specific. Most noticeable is the fact that there are half the number of pitch lines, in order to keep the HUD as decluttered as possible.

1 Press the ENTER key to select the air-to-air HUD mode.

2 Press the ENTER key again to cycle through any air-to-air missiles on board and activate the relevant air-to-air systems.

S-225 & AIM-120 TARGET TRACK BOXES: These appear around the targets when they are within range. When S-225 and AIM-120 are selected, you may see up to six targets locked in track boxes. You will notice that they are prioritised, with the letters A to F, depending upon their threat value. With ASRAAM, AIM 9M and cannon, only one track box will appear. You may override the computer's choice of target by pressing 'C', which will then select the next target in the sequence A to F. Notice that the currently selected target box has a solid outline, while the others have a broken outline.



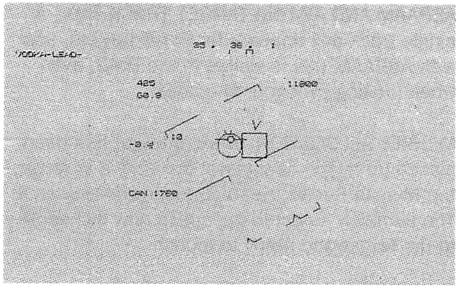
Multiple target tracking

ASRAAM AND AIM-9M TARGET TRACK BOX: A single track box appears for these targets, and with ASRAAM this is visible in the HMD, even when looking over your shoulder.

MISSILE ALLOCATION: When a target has been picked up by the designator box and is in range, the Missile Seeker Head diamond will lock on it. The currently selected missile is now locked on to the target and ready to launch.

PREDICTOR GUNSIGHT: When the Mauser 27 mm cannon is selected, a circular predictor sight appears, which shows where your shells will strike if fired at that moment. The outer ring of the circle is also a range indicator. A complete circle shows that the target is at three miles or more, which represents a difficult shot. As you get closer, the line moves around and at the half-way mark you are with one-and-a-half miles, which is a good range to go for a kill.

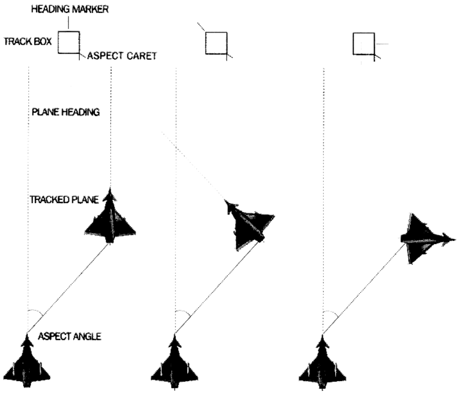
## AIR-TO-AIR HUD AND HMD MODES



The predictor gunsight with range clock

**AIMING RETICLE:** This 'kill circle' appears on the HUD when an air-to-air missile is selected. The size of the Aiming Reticle depends on the chosen missile: a small circle is used for long-range stand-off weapons such as the S-225, and a large circle is for short-range missiles. Because missile flight envelopes are accurately modelled, you should ensure that your target is within the reticle in order to ensure the best possible shot.

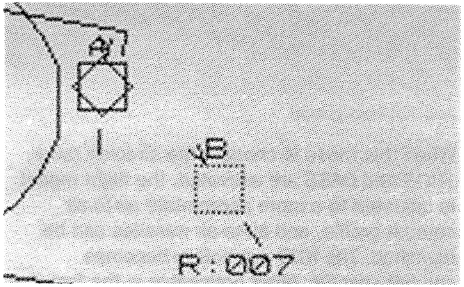
**ASPECT ANGLE CARET:** On each track box, this shows the target aircraft's position relative to you. If the caret is at the bottom of the track box, the target is flying away from you. If the caret is at the top, the target is flying towards you.



Understanding the aspect caret and heading marker. A constant aspect angle but with changes of heading

**TARGET HEADING LINE:** On each track box, a solid line moving around the box shows the target aircraft's heading relative to yours.

**TRACKING INFORMATION:** On any aircraft being tracked by your radar. F=Fighter, B=Bomber, R=Refueller, A=AWACS.

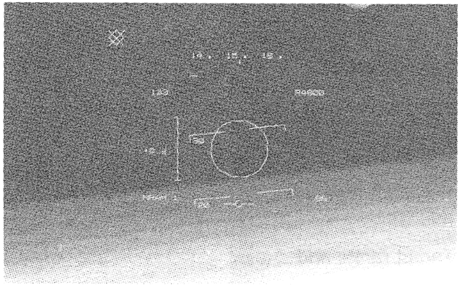


The aspect caret and target heading line

**AIRCRAFT CLOSING SPEED (KNOTS)** In short range missile and cannon mode, the closing speed between you and the target is displayed in the bottom right of the HUD; e.g. + 80 means that you are travelling 80 knots faster than the enemy.

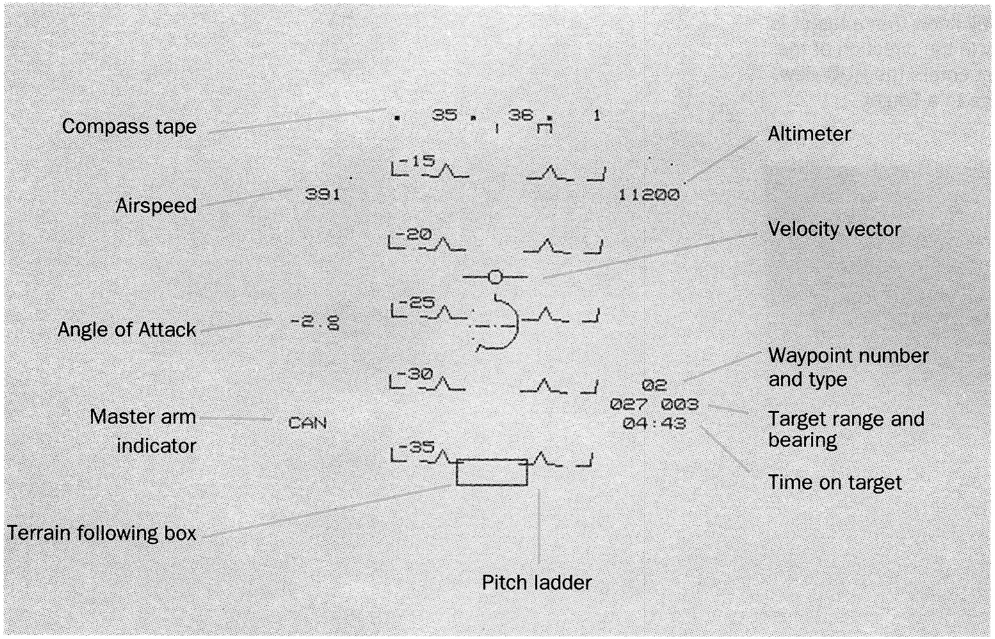
## AIR-TO-AIR HUD AND HMD MODES

DIAMOND X: When you see this diamond with an 'X' at its centre, you will know that a target is outside the HUD view. Fly in the direction of the Diamond X until the target enters the HUD view. The Diamond X will change to a Target Designator Box.



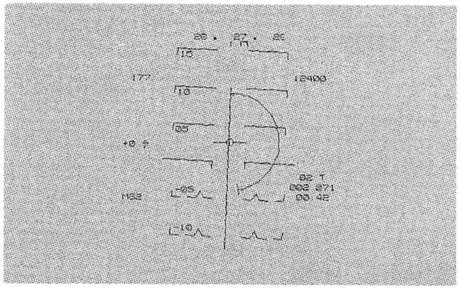
Follow the diamond X

## AIR-TO-GROUND HUD AND HMD MODES

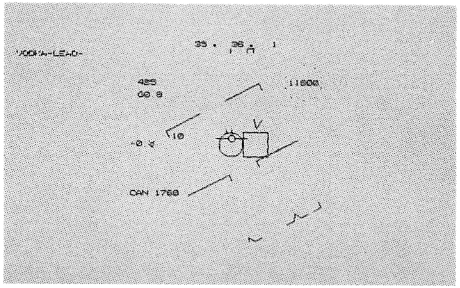

Compass tape
35
36
1
Altimeter
-15
Airspeed
391
11200
Velocity vector
-20
-25
Angle of Attack
-2.8
Waypoint number and type
-30
02
027 003
Target range and bearing
04:43
Master arm indicator
CAN
Time on target
-35
Terrain following box
Pitch ladder

# EF2000 AVIONICS

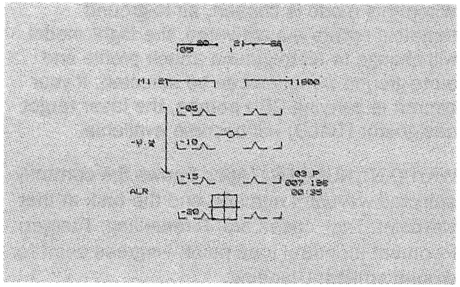
## AIR-TO-GROUND HUD AND HMD MODES



Freefall bombing mode



The cannon and CRV-7 sight



The ALARM sight

DROPPING A FREEFALL BOMB: When you select this weapon, a bomb fall line appears in the centre of the HUD, together with a count-down clock that starts when you are 65 seconds from the target. If the target is predefined there will be a small triangle on the HUD indicating the nearest waypoint. The target is marked by an'X'. The small horizontal line is the Continously Computed Impact Point and shows where the weapon will fall if it is launched at that moment. Approach the target at an angle (up to 40 degrees) and as soon as the CCIP line crosses the target, release the bomb.

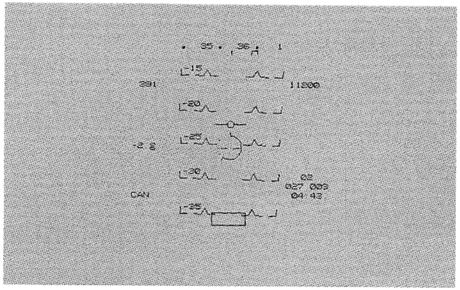
CANNON: When the air-to-ground cannon is selected, an AG predictor sight with range circle appears on the HUD.

CRV-7 SIGHT: This is a very similar sight to the one used for AG cannon, and shows where the rockets will impact.

ALARM SIGHT: This auto-tracking sight will only lock on to radar sources. ALARM may be fired in indirect mode, without any target, in which case it will travel for 15 miles and zoom climb to 40,000 ft, where it will wait for a target to switch on its radar. Alternatively, if there are targets in direct view of the missile, it will designate them with a small square in the HUD. The missile may then be launched when a small cross appears in the square.

## AIR-TO-GROUND HUD AND HMD MODES

When this mode is chosen, air-to-ground targeting radars are activated, the flight model will change to air-to-ground attack profile and air-to-ground weapons can be selected. If your aircraft is carrying GBU bombs, the laser target designator (TIALD) will become available.



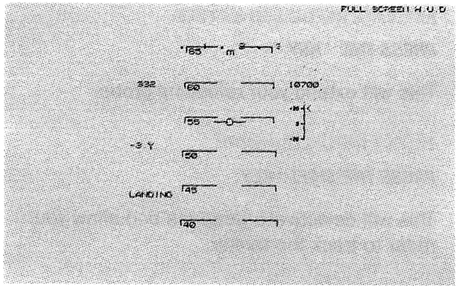
The AG HUD mode

WAYPOINT NUMBER/TASK: Shows the currently selected waypoint number, and the task at that waypoint. Task codes are: R-refuelling; T-target; P-combat air patrol loop point; I-ingress point for ground strikes; L-landing.

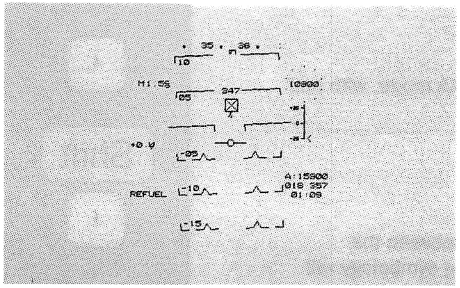
TIME ON TARGET (TOT): Shows how far you are from your currently selected target in minutes and seconds.

RANGE TO TARGET: Shows how far you must travel to your target in nautical miles.

## LANDING AND REFUELLING HUD MODES



Instrument landing system HUD mode



Refuel HUD mode

A variation of the navigation mode HUD comes into effect when the Instrument Landing System is activated. If ILS is available or in range, a small box will appear in your HUD.

ACTIVATE ILS: Choosing ILS with thirty miles of an airfield will activate the Command Flight Path Display (CFPD), which is a corridor in the sky that helps you make perfect landings. Simply fly through the boxes, steering with the aid of your Velocity Vector (VV). To make landing easier still, select autothrottle in the autopilot screen, and program it with a speed of 150 knots. When you have touched down, remember to switch off the autopilot, prior to applying the brakes.

UNDERCARRIAGE DISPLAY: When ILS is activated, so is the undercarriage indicator in the bottom centre of the HUD. Three U's mean that your undercarriage is up. Three D's indicate that the under carriage is down.

A variation of the air-to-air HUD comes into effect when you are set to refuel.

Instead of an enemy target, the HUD tracks the refuel aircraft. Note that all weapons systems are shut down for refuelling. The closing speed is displayed above the tracking box.

## OPERATING THE HUD MODES

Enter

### SELECT AA MODE

*PRESS ENTER*

This will switch the HUD to AA mode, with half the number of pitch bars.

Enter

### CYCLE AA WEAPONS

*PRESS ENTER*

This will allow you to cycle between the available weapons. Targeting symbology will vary automatically, according to the weapon selected.

←

### SELECT AG MODE

*PRESS BACKSPACE*

This will switch the HUD to AG mode, giving you access to important waypoint information.

←

### CYCLE AG WEAPONS

*PRESS BACKSPACE*

This will allow you to cycle between the available weapons. Targeting symbology will vary automatically, according to the weapon selected.

‘

### ACTIVATE REFUELLER NOZZLE

*PRESS THE ‘ KEY*

This will extend your refuelling probe.

Shift ‘

### SELECT REFUELLER MODE

*PRESS THE SHIFT ‘ KEY*

This will de-activate weapons and allow your radar to track the tanker.

i

### SELECT ILS MODE

*PRESS THE i KEY*

The CFPD system displays boxes which you should try to follow with the velocity vector.

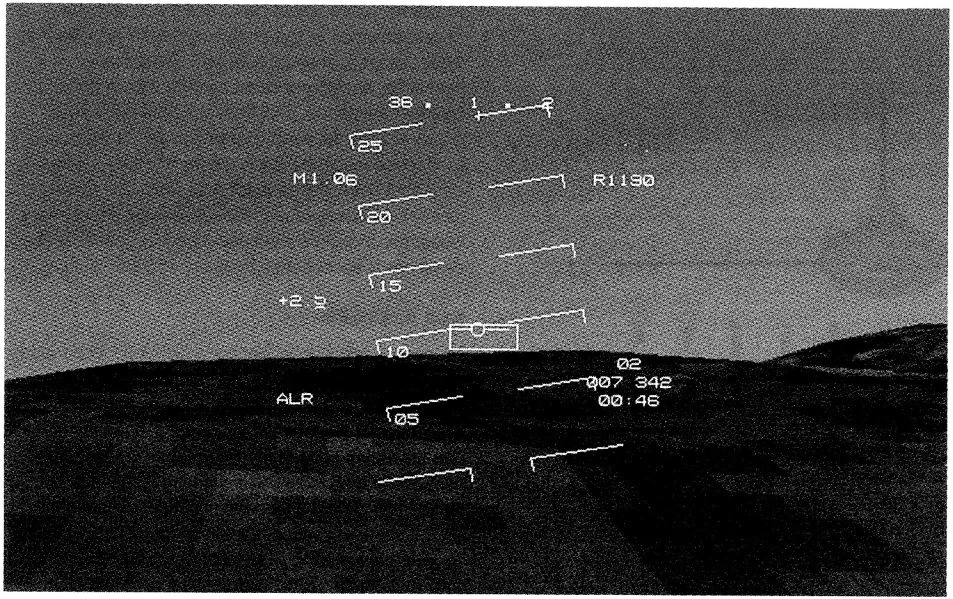
C

### CYCLE THROUGH MULTIPLE TARGETS

*PRESS THE C KEY*

When several track boxes are visible in the HUD, and you wish to override the ECR-90 prioritisation, press this key to cycle through the targets.

## DIGITAL TERRAIN SYSTEM



Simply fly the VV into the letter box

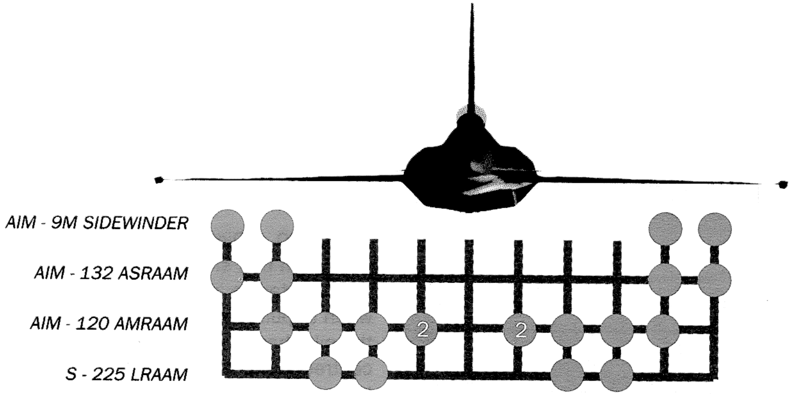
By eliminating the need for ground radar, a Digital Terrain System provides a stealthy and affordable way to help pilots fly ground-hugging profiles through hostile territory. The system projects flight cues into the HUD based on reference to digital terrain data. These data are cross-referenced with inputs from the aircraft's various navaids, such as the radar altimeter. Differences between the real and anticipated readings are resolved and relayed to the display system.

In EF2000, a Digital Terrain System predicts the flight path that should be taken, and projects a small rectangle into the HUD, showing the pilot when to pull back or push down on the stick. All the pilot has to do is keep the velocity vector centred in the small square. The system should keep the aircraft at least 200 ft clear of terrain and obstructions.

Real Digital Terrain systems have other uses, including assistance in weapons cueing. In EF2000, use the system for stealthy low-level attack approaches in well-defended territory.

# EF2000 WEAPONS

## INTRODUCTION TO AIR-TO-AIR WEAPONS



**EF2000 carries the latest air-to-air weapons**

In recent years there have been substantial improvements in the performance of AA missiles. With better radars and missile guidance systems, designers have concentrated on building weapons and delivery platforms that excel at both Beyond Visual Range (BVR) combat and close combat. Each demands very special qualities from the aircraft and from the missile design, which is why EuroFighter and its primary weapons systems such as ASRAAM have been developed specifically for each other.

### BVR MISSILES

To have a chance of hitting a difficult target such as the SU-35 at long-range, BVR missiles need endurance, speed, and jamming-resistance. They also need a degree of agility for manoeuvring in the final phase of flight, and stealth properties can make the difference between a hit and a miss. The delivery aircraft must be capable of fast acceleration to high Mach numbers, in order to give the missile maximum inertia at launch, and must offer good supersonic turn rates, in order to outrun any missiles an enemy might fire in return.

# EF2000 WEAPONS

## INTRODUCTION TO AIR-TO-AIR WEAPONS

### DOGFIGHTING MISSILES

In contrast, shorter range missiles for use in visual dogfights need tremendous agility, so that they hit a fast manoeuvring target. ASRAAM derives snake-like agility from thrust vectoring, the technique of steering with the motor exhaust, which made the Harrier VSTOL aircraft possible. Coupled with a Helmet Mounted Sight, ASRAAM is all the more deadly because it can be fired at targets over the pilot's shoulder; for example across a circle in a turning dogfight. This is known as off-boresight weapons delivery.

### CANNON

The Vietnam war taught the Americans that carrying missiles alone was not enough in close combat against an agile enemy. Even though missile performance has improved dramatically, cannons are still deemed necessary on fighter aircraft. The presence of many shoulder launched SAMs in modern battlefield environments makes strafing very risky indeed, and so cannon are less important in the Air- to-Ground role.

| **Weapon** | **Useful range**<br>miles (head-on)<br>Km (head-on) | **Weight**<br>Kg<br>lb | **Speed**<br>miles/sec. @<br>sea level | **Drag Factor**<br>x1<br>X4 |
|---|---|---|---|---|
| Cannon | 3<br>5 | 87<br>220 | 1.2 | - |
| AIM-9M | 5<br>8 | 87<br>191 | 0.3 | 1.01<br>4.04 |
| ASRAAM* | 10<br>15 | 97<br>191 | 0.4 | 1.10<br>4.40 |
| AMRAAM | 30<br>48 | 157<br>346 | 0.6 | 1.58<br>6.32 |
| S-225* | 50<br>80 | 160<br>353 | 0.9 | 1.91<br>7.64 |

*Weapons performance comparison: EuroFighter carries NATO's best AA weapons, including: the stealthy S-225 long-range missile; the AIM-120 AMRAAM medium range missile; the ASRAAM high agility dogfighting missile; the aging but useful Sidewinder AIM-9M short-range missile; and the Mauser 27mm cannon.*

**Estimated performance*

# EF2000 WEAPONS

## INTRODUCTION TO AIR-TO-AIR WEAPONS

### EF2000 AA WEAPONS OVERVIEW

Even in the year 1995, missile manufacturers performance figures remain optimistic, with pilots quoting effectiveness of around 70% for some of the newer designs. There are many factors which determine whether or not a missile will hit its mark. Firstly, there is always the chance that the weapon will not arm itself.

Secondly, effective range is very much determined by your aspect angle to the target; so is the PK value, or Probability of Kill. For example, when you chase a plane from behind, effective missile range is at its shortest because the weapon must first catch up with the enemy. PK, however, is high in a rear-aspect shot because there is a greater chance of hitting the target in its vulnerable jet exhaust. On a nose-to-nose heading, weapon range is at its greatest because you are travelling towards the enemy at high closing speeds.

Last but not least, weapon effectiveness is altitude dependent: the higher you go, the greater the range, with ranges at sea level being almost half the maximum range.

In EF2000 we have carefully modelled all these characteristics, which means that you will always have to fly your plane into the best possible position prior to firing. On the radar, the white range-bar helps you determine the effect that altitude and aspect angle are having on the weapon parameters.

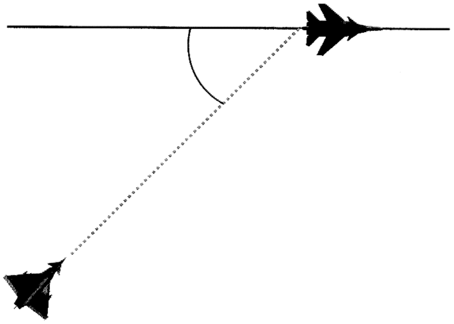
* AIM-9M Sidewinder- An old but adequate all-aspect heat-seeking missile.

* ASRAAM - Advanced Short-Range Air-to-Air missile, with IR seeker head.

* AIM-120 AMRAAM - Advanced Medium-Range Air-to-Air missile, guided by an on-board radar.

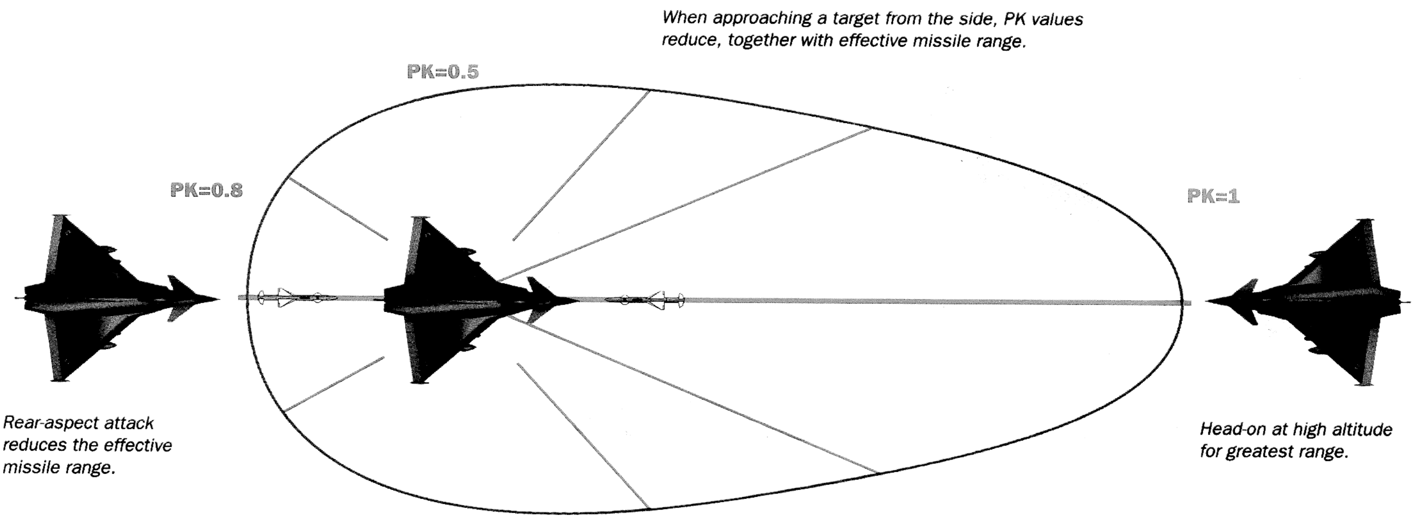
* S-225 - The new 'stealthy' long-range air-to-air missile, guided by radar.

In a typical Air-to-Air configuration, for use on intercept or Combat Air Patrol (CAP) missions, Eurofighter carries four long range S-225 missiles or four AMRAAMS, four dogfighting missiles such as the ASRAAM or Sidewinder AIM 9M, and 1760 rounds of high-explosive cannon shells. It is standard practise to carry drop tanks, because take-off and flight to cruising altitudes burn a lot of fuel.



Aspect Angle

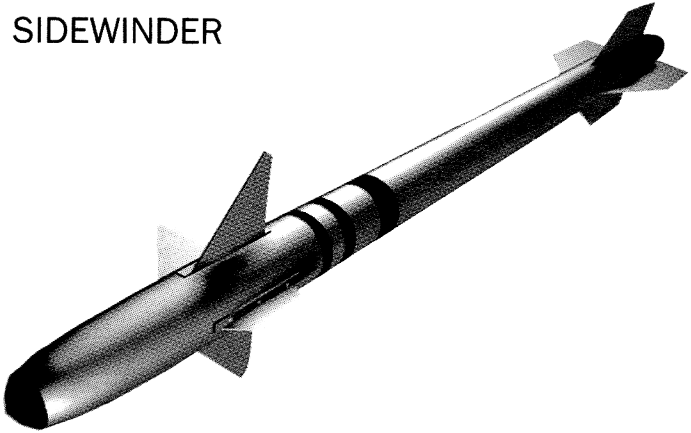
## INTRODUCTION TO AIR-TO-AIR WEAPONS

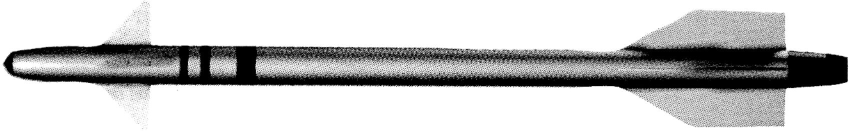

When approaching a target from the side, PK values reduce, together with effective missile range.
PK=0.5
PK=0.8
PK=1
Rear-aspect attack reduces the effective missile range.
Head-on at high altitude for greatest range.

**Heading aspect and missile range**

# AIR-TO-AIR WEAPONS

## AIM-9M SIDEWINDER





### DEVELOPMENT OF THE SIDEWINDER

The Sidewinder program started in the late forties at what is now called China Lake, California. Initially started on a very small budget, the Sidewinder was to be a novel, inexpensive weapon that would be wholly effective at shooting down other aircraft. The most important aspect of the weapon was the infra-red seeker technology, that would lock on to any heat emitting source in the sky (which also included the Sun with early models!). It has since grown into the world's most successful AA missile, has accounted for over 200,000 air to air missiles sold globally to many different airforces. It is now coming to the end of its development life.

The first Sidewinder, designated AIM-9B had revolutionary IR technology and fewer moving parts than other missiles and was rear-aspect only; in other words it needed to be fired at the target's six o'clock. Since then it has been upgraded several times to increase accuracy, speed, range and effectiveness, but has remained essentially the same. Most importantly it has become all-aspect, or capable of locking on to a target from any angle, and is able to distinguish between target, flares and the Sun.

EF2000 carries the AIM-9M variant, this comprises of all-aspect infrared tracking, active laser fusing and an 11.4 Kg high explosive blast fragmentation warhead. Although older and less capable than the new breed of AA missile, there is still place for the Sidewinder in modern combat due to its availability and relatively low-cost.

It is steered by four double delta planes located at the front of the missile, additional control coming from the rear wings in the form of "rollerons". The Sidewinder can accelerate to Mach 2.5 in about 2 seconds.

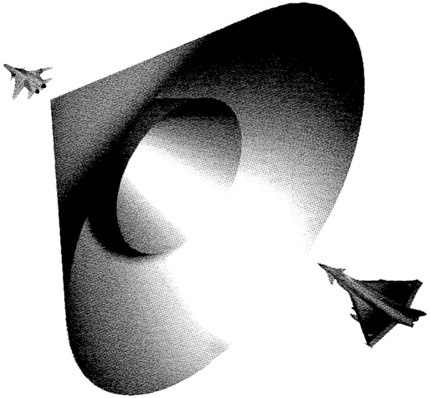
# AIR-TO-AIR WEAPONS

## AIM-9 SIDEWINDER

### APPLICATION

In operation the EF2000 would carry Sidewinders as a secondary short range missile, favouring instead the ASRAAM. However the Sidewinders are more plentiful, so may be used in cases where the ASRAAM is in short supply or where its capabilities are not as important.

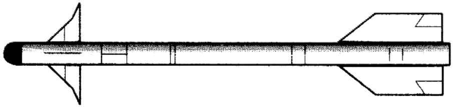
The AIM-9M is an infrared missile and even though it is 'all-aspect', the biggest heat signature will come from the rear of an enemy's aircraft. The missile's range is shorter than ASRAAM so in order to get a good kill from behind, the AIM-9M will need to be within five miles. Head on however increases the relative range of the missile according to the closing speed of the two aircraft, although the reduction of infra-red signature will reduce the likelihood of hitting the plane; i.e. a lower PK, or Probability of Kill.



The lethal cone in rear-aspect attack

| | AIM-9M Sidewinder |
|---|---|
| Length m | 2.87 |
| Diameter mm | 127 |
| Wingspan m | 0.64 |
| Weight kg | 87 |
| Warhead kg | 11.4 |
| Fuse | Active laser |
| Guidance | IR |
| Propulsion | Solid propellant |
| Range km | 8 |
| Range miles | 5 |

Performance Table

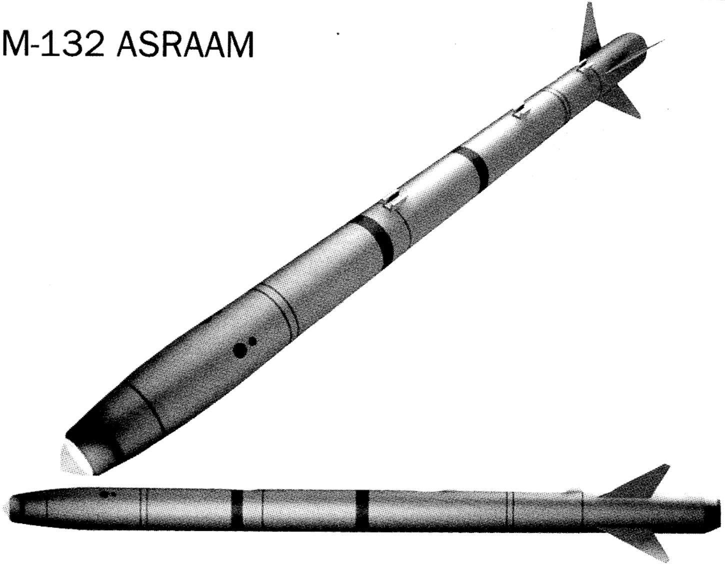


Aim-9M Sidewinder

When attacking a target using AIM-9M, position your aircraft so as to enable the missile's IR seeker to locate the target within your HUD. This may require a degree of violent manoeuvring at close range. Once the target has been acquired the Sidewinder will confirm it is tracking the target visually in the Track Box, and audibly through a distinctive growling tone. Once 'lock' has been achieved you may release the weapon. In adverse conditions of ECM, or when flares are being ejected by the target plane, the Sidewinder may break its lock in which case you must re-acquire it before launching. Once released, the Sidewinder requires no more thought from the pilot, enabling you to turn and leave.

# AIR-TO-AIR WEAPONS

## AIM-132 ASRAAM



The ASRAAM is guided by an advanced imaging infra-red seeker utilising image processing systems in order to recognise its target and give it all-aspect capability. ASRAAM differs from conventional missiles in offering high off-boresight targeting via a helmet mounted sight. In other words, the missile may be launched over-the-shoulder. Its performance is assisted by thrust vectoring, allowing fantastic turn capability of more than 30 G. The difference this makes in difficult turning dogfights is enormous, because you no longer have to point the plane's nose directly at the target. However, these missiles travel at speeds around Mach 4, which means that a slower moving plane pulling less G's can still outsmart the missile

### DEVELOPMENT OF ASRAAM

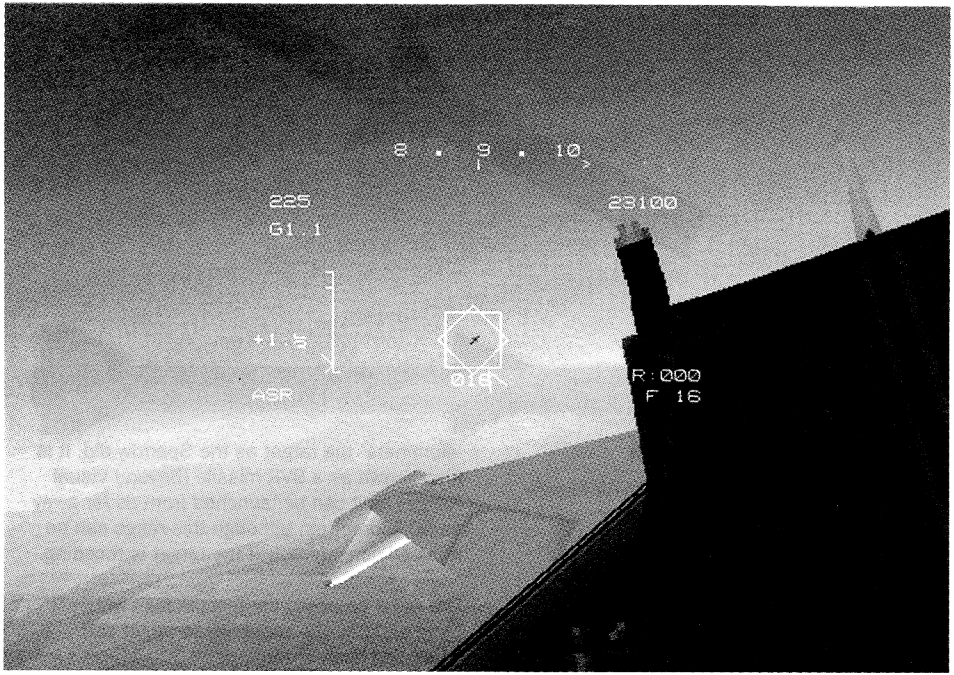
The Advanced Short Range Air-to-Air Missile (ASRAAM) programme was started in 1982 initially as a European enterprise, with the USA also producing the weapon. Although there was much interest early on in the programme, this waned as the US started to look at further developments in the Sidewinder family (AIM-9X) and the German co-contractors transferred all remaining interest to BAe. Several versions have been proposed from French weapons company Matra and also GEC-Marconi for a MICA ASRAAM, known as MICASRAAM.

# AIR-TO-AIR WEAPONS

## AIM-132 ASRAAM

| | **AIM-132 ASRAAM** |
|---|---|
| Length m | 2.9 |
| Diameter mm | 165 |
| Wingspan m | 0.45 |
| Weight kg | 87 |
| Warhead kg | 10 |
| Fuse | Active laser |
| Guidance | Imaging IR |
| Propulsion | Solid propellant |
| Range Km | 15 |
| Range miles | 10 |

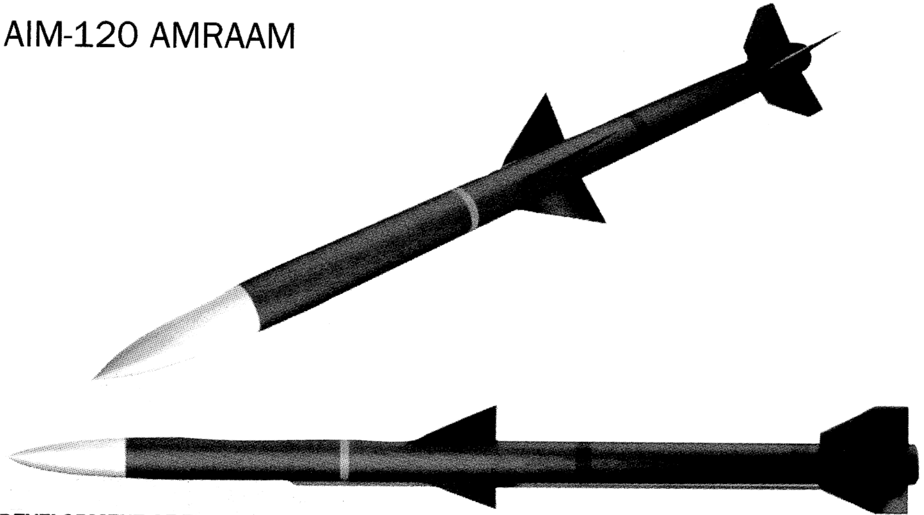
Performance Table


8 . 9 . 10
225
G1.1
23100
+1.5
016
ASR
R:000
F 16

Over the shoulder locking

# AIR-TO-AIR WEAPONS

## AIM-120 AMRAAM



### DEVELOPMENT OF THE AMRAAM

The Advanced Medium Range Air-to-Air Missile programme was started in 1975 as a replacement for the ageing Sparrow. The advantages over the Sparrow were better manoeuvrability, speed and range as well as improved resistance to ECM.

The AMRAAM has an active radar seeker which does not require the launch aircraft to 'illuminate' the target as the Sparrow did. It is also known as a BVR missile (Beyond Visual Range) as it can be launched from as far away as 50 kilometres, although this range can be reduced considerably if the target is receding.

The radar on board the missile falls within "I" band and has the capability to target self-screening jammer targets.

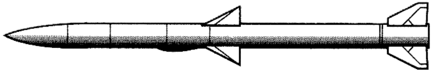
| | **AIM-120 AMRAAM** |
|---|---|
| Length m | 3.65 |
| Diameter mm | 178 |
| Wingspan m | 0.53 |
| Weight kg | 157 |
| Warhead kg | 22 |
| Fuse | Active laser |
| Guidance | Inertial, active radar |
| Propulsion | Solid propellant |
| Range km | 48 |
| Range miles | 30 |

Performance Table

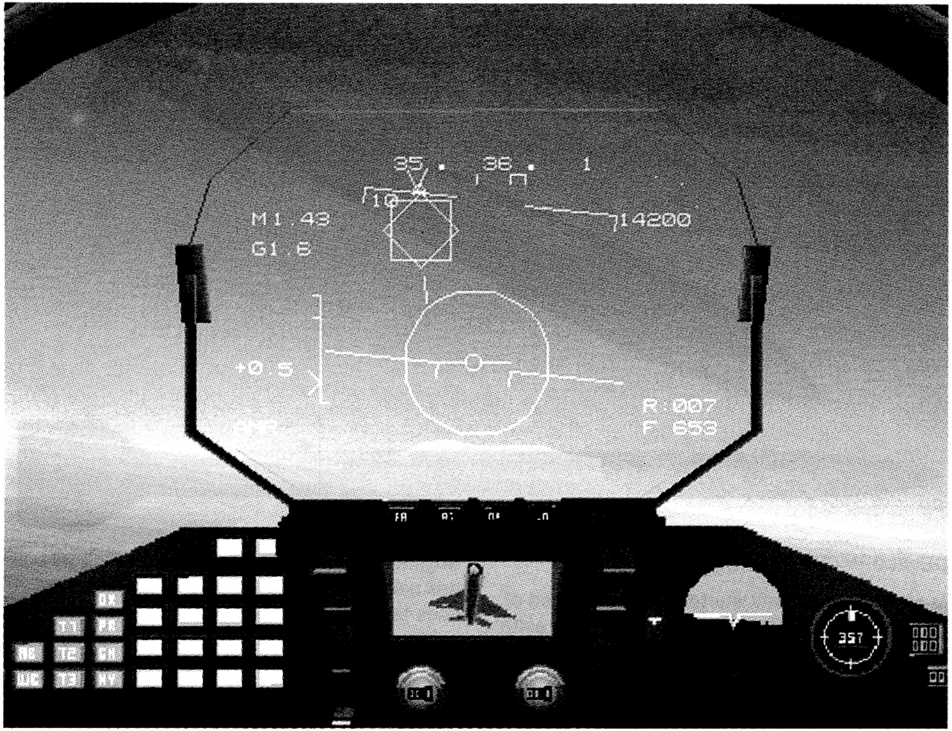
# AIR-TO-AIR WEAPONS

## AIM-120 AMRAAM

The primary air to air missile carried by the EF2000 will be AMRAAM for general engagement, although ASRAAM is favoured for close range. It is targeted by locking the radar on a tracked enemy. Once fired, the missile then uses on board inertial guidance with command updates from the launch aircraft. In its final phase it switches on the active radar seeker. As the radar only switches on in the terminal phase, the missile is less susceptible to any jamming, it also makes the missile hard to detect until it is too late.



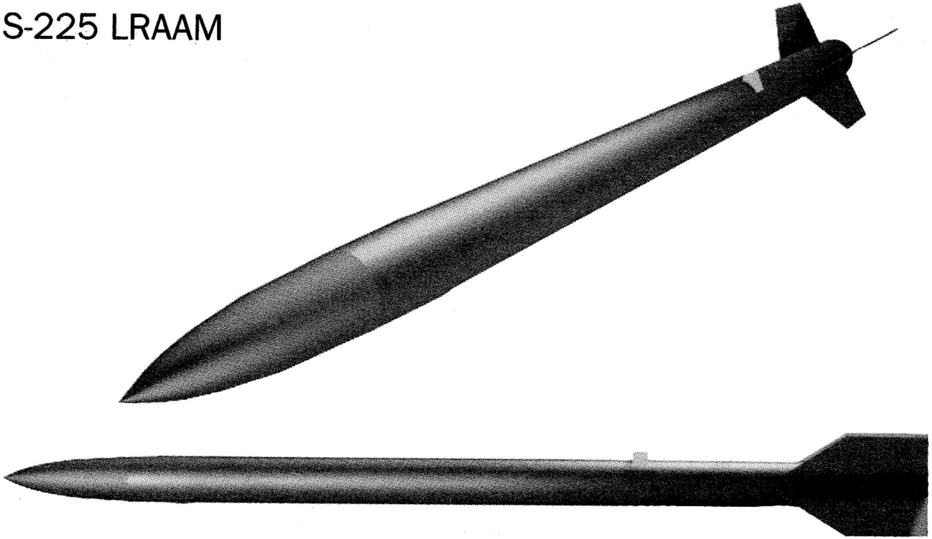
AIM-120 AMRAAM



AMRAAM tracking

# AIR-TO-AIR WEAPONS

## S-225 LRAAM



### DEVELOPMENT OF THE S-225

in 1991 development started on a new breed of air to air missile. The missile would have stealth characteristics and new guidance systems, and it would be compatible with the emerging technology found in the advanced tactical fighter aircraft being developed by European and American companies.

Originally based on the Skyflash, the new missile has neither mid-body controls or tail fins, but uses tail control surfaces instead. The smoky solid rocket propellant was replaced with a new smokeless motor which lets the missile alternately propel itself then coast without power, in order to boost range and improve stealth. The motor reserves enough power to deliver an optimal terminal velocity with which to attack the target. For the long range role, the missile was given a mid-course guidance data link, enabling range to be increased to around 100 km.

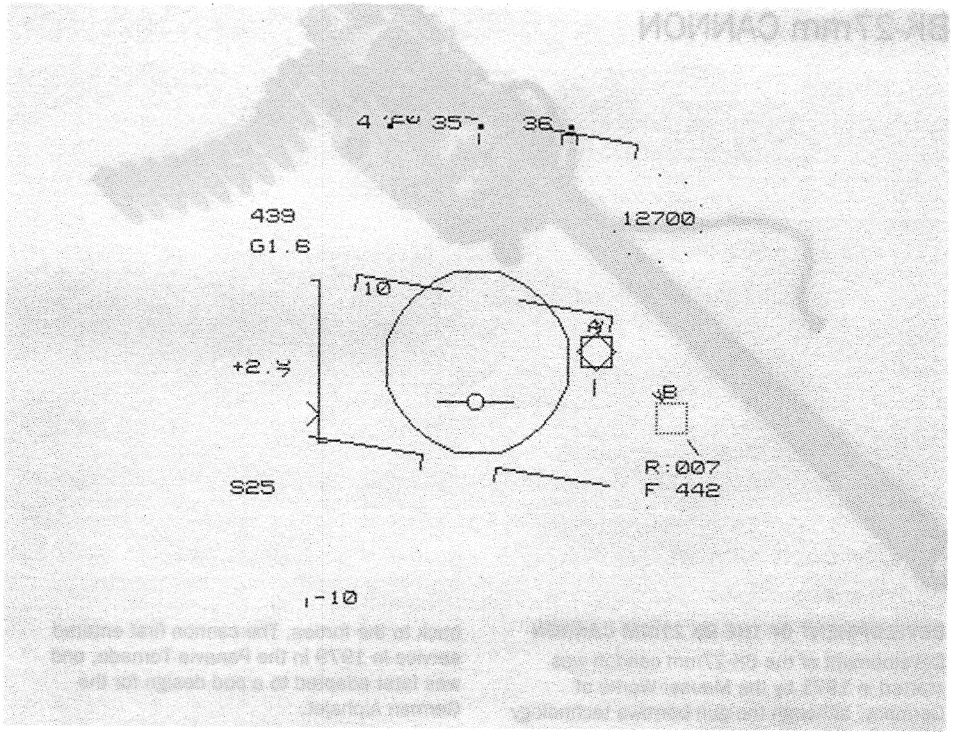
| | **S225 LRAAM** |
|---|---|
| Length m | 3.68 |
| Diameter mm | 203 |
| Wingspan m | 0.56 |
| Weight kg | 160 |
| Warhead kg | 30 |
| Fuse | Active laser |
| Guidance | Data Link, active radar |
| Propulsion | Dual Rocket |
| Range Km | up to 80 |
| Range miles | up to 50 |

Performance Table

## S-225 LRAAM

Targeting of the long-range 'stealth' missile is identical to the ASRAAM system except that only targets within the HUD may be locked.

It is better to engage at long distance than to enter a dogfight, at the risk of giving away your position. The stealthy attributes of this missile, however, go a long way in keeping you location hidden. This weapon may also be used at a similar range to AMRAAM, although the poor availability of the weapon would make AMRAAM the preferred choice.



Multiple target tracking using the S-225

# AIR-TO-AIR WEAPONS

## BK-27mm CANNON

The BK-27mm cannon is based on the same principle as the revolver, and uses gas drive for the gun feed and electrical power for the firing mechanism. This gives a full rate of fire from the first round onwards. The single barrel is easily Interchangeable and the five chamber drum can be fed from either left or right. One more advantage of the system is its ability to be mounted in almost any position, giving full flexibility to the system. The EF2000 has a single BK-27mm cannon mounted in the starboard wing root.

The ammunition used in the EF2000 is a high explosive round mostly suited to aerial warfare. Although there is an air-to-ground firing mode, CR-V7 rockets would be favoured over the cannon.

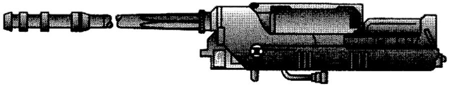
### DEVELOPMENT OF THE BK 27MM CANNON

Development of the BK-27mm cannon was started in 1971 by the Mauser-Werke of Germany, although the gun borrows technology from other Mauser projects, some of which date back to the forties. The cannon first entered service in 1979 in the Panavia Tornado, and was later adapted to a pod design for the German Alphajet.

# AIR-TO-AIR WEAPONS

## BK-27mm CANNON

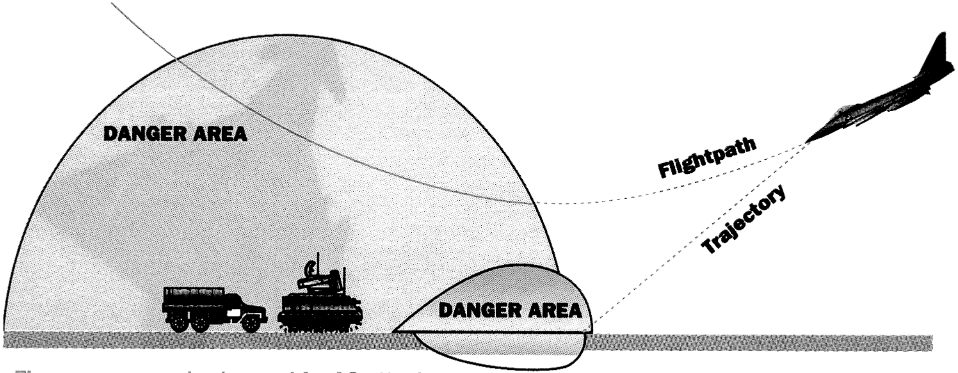
The rate of fire is set to 1700 rounds per minute. With a total ammunition store of 1760 rounds it will not take long to deplete the guns supply. Short cannon bursts are more effective overall than keeping your finger on the trigger until the target is destroyed. In addition, it is advisable to open fire only when the target is well within range, and to avoid firing at violently manoeuvring targets unless you are depending on autofire. This triggers a short burst whenever the predictor sight crosses through the centre of the track box.



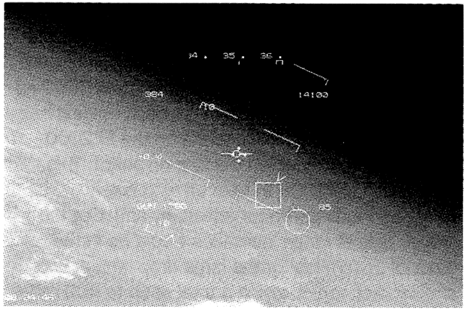
BK-27mm Cannon

| | **BK-27mm Cannon** |
|---|---|
| Length m | 2.31 |
| Calibre mm | 27 |
| Weight kg | 100 |
| Ammunition | High explosive rounds |
| Guidance | HUD predictor |

Performance Table



The cannon may also be used for AG attacks



The predictor sight

# AIR-TO-AIR WEAPONS

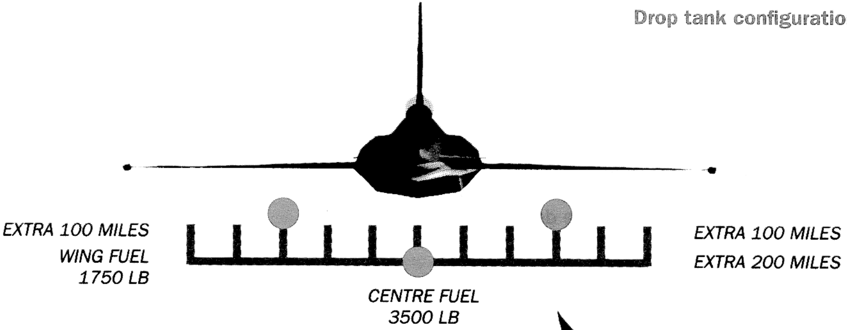
## DROP-TANKS

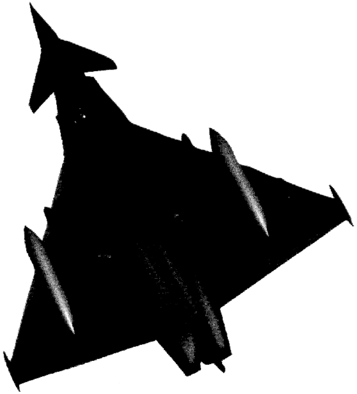
Drop-tanks were first used extensively during the Second World War. The advantage of being able to jettison the tanks was increased performance in dogfighting. It was found that significant increases in range gave the aircraft much greater flexibility without the need to increase their overall size so that they still retained their agility and speed.

Today the increased use of mid-air refuellers gives the modern fighter almost unlimited range. This in conjunction with drop-tanks means that the aircraft can give more of its space over to other requirements such as improved engines or greater weapons payloads.

EF2000 has three 'wet' points for drop-tanks: one under the fuselage or two smaller tanks under the wings. The large centre-line tank can hold 3500 kg of fuel, with the underwing tanks each holding half this amount. Put all three tanks on the EF2000 and you almost doubled the fuel on-board. This enables the EF2000 to take off with heavy weapons loading without adversely affecting the range. Typical range increases would be in the order of 200 miles for the large drop-tank or two smaller drop-tanks, giving a total of up to 400 miles if all three are fitted.

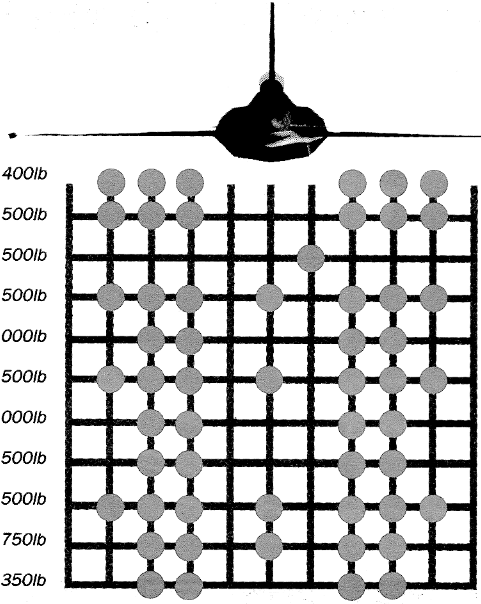
**Drop tank configuration**





# EF2000 WEAPONS

## INTRODUCTION TO AIR-TO-GROUND WEAPONS



| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *ALARM 400lb* | ● | ● | ● | | | | ● | ● | ● | *SEAD/CAS/AFLD*<br>*Anti-radiation missile* |
| *CRV7 500lb* | ● | ● | ● | | | | ● | ● | ● | *CAS*<br>*Unguided rocket* |
| *LASER SIGHT 500lb* | | | | | | ● | | | | *FOR GBU BOMBS* |
| *GBU 12 500lb* | ● | ● | ● | | ● | | ● | ● | ● | *STRIKE/AFLD/CAS*<br>*Laser guided bomb* |
| *GBU 16 1000lb* | | ● | ● | | | | ● | ● | | *STRIKE/AFLD/CAS*<br>*Laser guided bomb* |
| **IRON MK 82 500lb* | ● | ● | ● | | ● | | ● | ● | ● | *STRIKE/AFLD/CAS*<br>*Standard guided bomb* |
| **IRON MK 83 1000lb* | | ● | ● | | | | ● | ● | | *STRIKE/AFLD/CAS*<br>*Standard bomb* |
| *MAVERICK IR 500lb* | | ● | ● | | | | ● | ● | | *CAS/SEAD*<br>*IR guided AG missile* |
| *DURANDAL 500lb* | ● | ● | ● | | ● | | ● | ● | ● | *AFLD*<br>*Anti-runway bomb* |
| *BL 755 750lb* | | ● | ● | | ● | | ● | ● | | *SEAD/CAS*<br>*Cluster bomb* |
| *SEA EAGLE 1350lb* | | ● | ● | | | | ● | ● | | *ANTI-CARRIER*<br>*Anti-ship missile* |

**EF2000 AG weapons loading**

**High-Drag versions also available.*

EuroFighter was designed from the start as a multi-role aircraft, which meant it must also perform superbly in the air-to-ground role. It has therefore been designed to carry a wide arsenal of AG ordnance, including the latest 'smart' weapons.

### SMART BOMBS

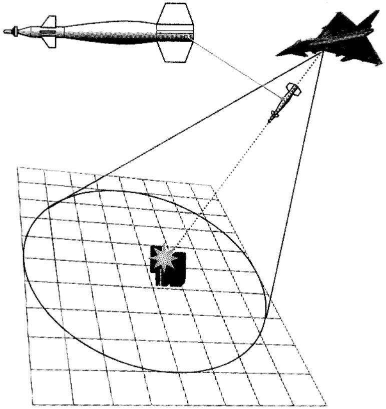
Media coverage of the Gulf war in 1991 first brought the image of 'smart' weapons to the attention of the general public. These awesome devices could be launched from an airplane or ship and travel miles and then hit a target with an accuracy measured in just a few feet or metres. The goal was maximum effectiveness with minimum collateral damage, although experience showed that even the best technology can still go tragically wrong.

Smart weapons have been developed over many years, going back to the fifties and sixties, but it was the first time they had been tested so openly. The success of the weapons was easy to see, as the public was bombarded with images of bridges and bunkers being destroyed, cruise missiles following roads into Baghdad and penetrating the window of a military headquarters, and Scud rocket launchers being detected and destroyed at night.

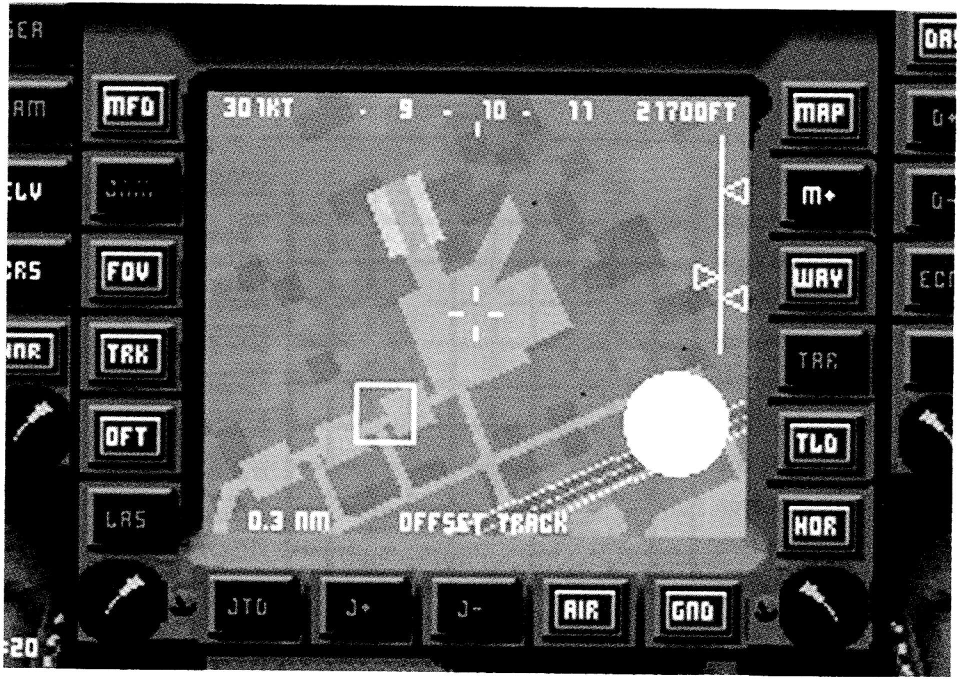
# EF2000 WEAPONS

## INTRODUCTION TO AIR-TO-GROUND WEAPONS

These weapons allow a new approach to attacking targets. For instance, a hardened aircraft shelter is tough to crack with anything but a direct hit, or a near miss with a very large bomb. The application of the laser made precision bombing possible, by illuminating the target and allowing the bomb to home in to the reflected light. Now pilots could put a relatively small bomb down ventilation shafts, making the destruction of reinforced targets a clinical task.



Laser guided bomb


MFD
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0.3 nm
OFFSET TRACK
MAP
M+
WAY
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TLD
HOR
JTD
J+
J-
AIR
GND

TIALD for aiming LGB's

# EF2000 WEAPONS

## INTRODUCTION TO AIR-TO-GROUND WEAPONS

### CONVENTIONAL BOMBS

Computers have made direct hits more likely with conventional weapons. They have the processing power it takes to perform complex mathematical models for ballistics and aerodynamics, which are used to predict the fall line of unguided bombs. To help pilots get their bombs on-target, modern attack aircraft feature computerised navigational attack systems, which calculate the effect of wind, airspeed, air pressure, g-loading, bank angle, altitude, rate of descent and other factors on the ballistic trajectory of bombs.

Different attack profiles also create their own problems. At low levels, strong air turbulence may upset accuracy and may also result in bombs not having enough time to arm themselves properly. This happened with Argentinian bombs during the Falklands War. Retard mechanisms are meant to solve this problem. At medium or high altitudes the margin of error obviously increases dramatically. The problems are compounded by the pilot trying to manoeuvre his aircraft to avoid enemy anti-aircraft fire or surface-to-air missiles (SAM).

### AIR-TO-GROUND MISSILES

Image recognition, or pattern recognition, is another application of computers for missile guidance. Target shapes are identified by the system, and the location data is transferred to the missile, which then guides itself to the destination. Some Mavericks are guided this way, and they provide the pilot with a high degree of flexibility in targeting. However, it is worth noting that in the Gulf War, pilots often fired at previously destroyed targets, underlining the error factor.

### SPECIAL BOMBS

Every target represents a different problem, which is why there are so many different types of weapons available. Two special problems are hitting widely dispersed armoured vehicles in open terrain from a fast jet, and destroying enemy runways. As a result, the cluster bomb and Durandal were invented.

The cluster weapon is the bombing equivalent of a shotgun, and is a devastating weapon when used on infantry and soft-skinned vehicles. Cluster bombs scatter smaller sub-munitions or bomblets, and each sub-munition can be tailored to specific targets; for example, anti-personnel or anti-armour.

Hitting a runway is also a difficult proposition, which is why it's important to make sure that when you hit the target, it stays damaged for the maximum duration. Durandal does just this, by powering itself through the tarmac with the help of a rocket motor, and exploding below the surface to make a huge cavity that's hard to repair.

### CHOOSING THE RIGHT WEAPON

The choice of weapon is dependent on the target to be attacked. In most cases there may be a few weapons you could use, but there is usually one that is just right for the job. If the right weapon is not available, it may be better to wait rather than rush in with an unsuitable load. In the case of SAM launchers this would lead to certain death.

In EF2000, several pre-determined packages have been stored in the arming screen for different types of mission. Although you may have personal preferences, these packages represent a realistic choice of the weapons officer.

# EF2000 WEAPONS

## INTRODUCTION TO AIR-TO-GROUND WEAPONS

| Target | First choice weapon | Second choice weapon |
|---|---|---|
| Ships | Sea Eagle | Maverick or LGB |
| Large building | LGB | MK-83 |
| Medium building | LGB | MK-83 |
| Small building | LGB | MK-82 |
| Bridge | LGB | Maverick |
| Runway | Durandal | MK-83 |
| Hangar | LGB | LGB |
| Bunker | LGB | LGB |
| POL tank | LGB | MK-82 |
| SAM launcher | ALARM | BL-755 Cluster Bomb |
| Tank | Maverick | BL-755 Cluster Bomb |
| Personnel carrier | Maverick | CRV-7 |
| SCUD launcher | LGB, Maverick | CRV-7 |
| Personnel | BL-755 Cluster Bomb | CRV-7 |

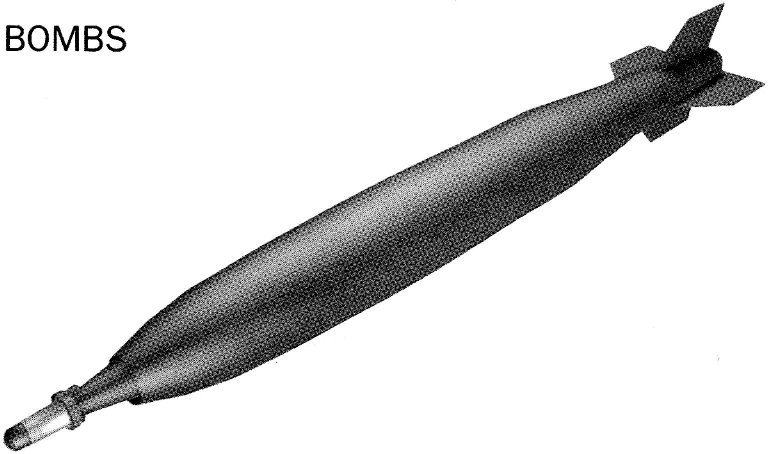
**Air-to-ground weapon selection chart**

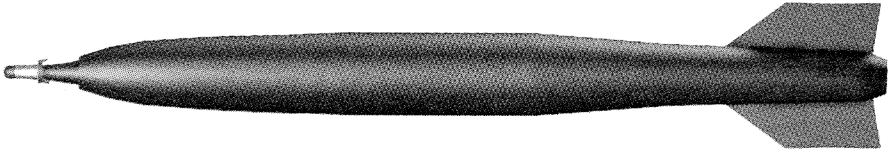
| Weapon | Section to look in |
|---|---|
| Iron bombs | HUD |
| Laser guided bombs | TIALD |
| Durandals | HUD |
| Cluster bombs | HUD |
| Sea Eagle | ECR-90 RADAR |
| ALARM anti-radiation missiles | HUD |
| Maverick missiles | MAVERICK AIMING |
| CRV-7 unguided rockets | HUD |
| Cannon | HUD |

**Aiming AG weapons - where to look**

# AIR-TO-GROUND WEAPONS

## IRON BOMBS





### DEVELOPMENT OF THE MK-80 SERIES

The development of the low drag general purpose bomb began in the fifties, and the Mk 80 Series has now become the standard adopted by many countries. The four basic types of bomb are very similar in design, differing only in size and weight. The smallest is the Mk-81 which weighs 250lb. Each bomb is constructed in the same way; a steel body with cruciform tail and tempered steel nose.

Little has changed since the bomb was first designed except for modifications to fusing and filling. New delivery techniques have been incorporated into the design such as retardation devices. The weapon is also produced for the Paveway series of laser guided bombs, losing its fins in favour of an upgrade kit.

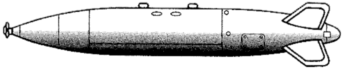
Fusing for the bomb depends on its usage but the basic types for these bombs are: impact fuses, which detonate on contact with the target; impact with delay, which explode a short time after contact with the target causing cratering and structural damage; and airburst fuse, which detonates the bomb before it has hit a target causing collateral damage to the general area.

**APPLICATION**

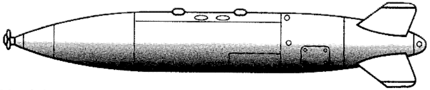
| | |
|---|---|
| Acceptable Targets: | Buildings, depots, oil facilities on land |
| Poor Targets: | Almost anything else |
| Effective Range: | Nil |
| Max Speed: | Free-fall bomb |
| Attack Technique: | Level bombing or dive bombing |
| Level Release: | 3,000' |
| Dive Release: | Dive from 8,000', release at 3,000' |

# AIR-TO-GROUND WEAPONS

## IRON BOMBS



MK-82



MK-83

The Mk 80 bombs have standard HE (High Explosive) warheads, which can be easily modified to improve performance in different attack scenarios. Pilots who used the bombs in the Gulf War stated that the HE was devastating if a direct hit was scored on tanks, armoured vehicles, dug-in artillery or buildings. A near miss from a Mk.84 2000lb bomb was also reported to be almost sure of knocking out an armoured vehicle.

| Bomb type | LGB | Free-fall |
|---|---|---|
| 2,000 ft | 5 nm | 0.5 nm |
| 5,000 ft | 7 nm | 1.5 nm |
| 10,000 ft | 10 nm | 2.5 nm |
| 20,000 ft | 15 nm | 3.5 nm |

Typical ranges at different delivery altitudes

### HIGH DRAG VERSIONS

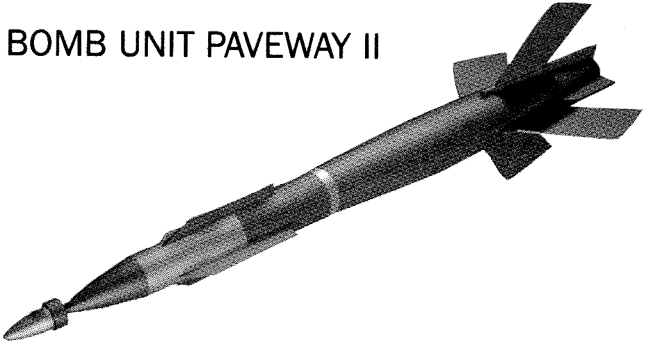
Available in EF2000 are high drag versions of the bombs, which may be safely released at altitudes of around 500 ft.

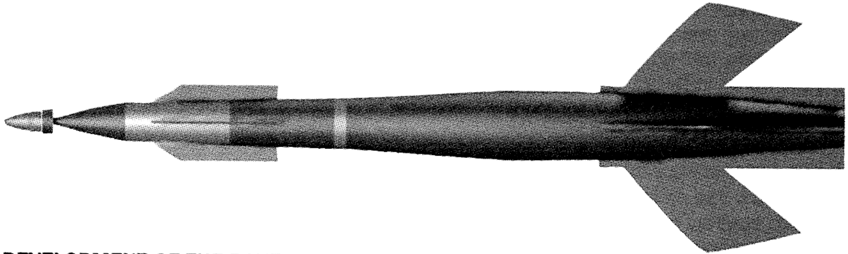
| | MK-82 | MK-83 |
|---|---|---|
| Length m | 2.21 | 3.0 |
| Diameter mm | 273 | 350 |
| Wingspan m | 0.38 | 0.48 |
| Weight kg | 241 | 447 |
| Warhead kg | 89 | 202 |
| Fuse | Various | Various |
| Guidance | HUD predictor | HUD predictor |
| Propulsion | Freefall | Freefall |
| Range | Dependent on launch | Dependent on launch |

Performance Table

# AIR-TO-GROUND WEAPONS

## GUIDED BOMB UNIT PAVEWAY II





### DEVELOPMENT OF THE PAVEWAY SERIES

Although it is generally assumed that the Paveway bombs are a recent invention, they have actually been around since the mid sixties. Indeed the first production models saw service in Vietnam in 1968. The success of the weapon led to further development in the field of modular design, enabling the guidance and tail units to be used as a kit with several types of standard free-fall bombs.

The Paveway II series has much of the technology of the earlier bombs with the addition of new folding rear wings, which make the bomb compatible with many types of aircraft. Other modifications include the guidance unit, which now has plastic lenses, integrated circuitry and improved electronics. Manoeuvrability has also been dramatically improved.

Paveway II bombs are classed into several groups dependent on the bomb unit fitted with the kit. GBU-10 is based on the MK-84 2000 lb GP bomb; GBU-12 is based on the MK-82 500 lb bomb; and GBU-16 is based on the MK-83 1000 lb bomb.

### APPLICATION

| | |
|---|---|
| Acceptable Targets: | Almost any stationary target |
| Poor Targets: | Ships or moving vehicles |
| Effective Range: | See table |
| Max Speed: | Glide bomb |
| Attack Technique: | Toss bombing or level bombing |
| Toss Release: | 500’ and climb |
| Level Release: | 15,000 or 5,000 ft depending upon target |

# AIR-TO-GROUND WEAPONS

## GBU PAVEWAY II

| | **GBU12** | **GBU16** |
|---|---|---|
| Length m | 3.33 | 3.68 |
| Diameter mm | 273 | 350 |
| Wingspan m | 1.68 | 1.34 |
| Weight kg | 225 | 454 |
| Warhead kg | 89 | 202 |
| Fuse | Impact | Impact |
| Guidance | Laser | Laser |
| Propulsion | Freefall | Freefall |
| Range | See table | See table |

Performance Table

The EF2000 carries the GBU12 and GBU16 as standard. The TIALD Thermal Imaging And Laser Designation system is probably the most accurate bombing system in the world for single-seat and twin-seat aircraft. Originally fitted to the two-seat Tornado and now single-seat Jaguars, TIALD feeds the pilot with all the data needed to make the correct attack run, illuminates the target, and calculates the correct release point for the weapon. On release, the weapon derives its power from a small on-board generator, which will drive the control surfaces for just over one minute. For this reason, the delivery aircraft must always fly within one minute from the target. See the section on TIALD in EF2000 AVIONICS for more details on the delivery system.

It is claimed that approximately 90 per cent of laser-guided bombs landed on target during the Gulf War. However, contrary to popular belief, it requires great skill and good weather to ensure a bullseye. If cloud obscures the target, then the laser cannot see it and the lock will break, causing the bomb to free fall ballistically, consequently missing the target and possibly causing collateral damage.

It usually takes at least two minutes for aircraft flying at medium to high altitudes to acquire and then designate targets. While the bomb is dropping to the target the pilot has to keep the target illuminated - a procedure requires great skill, and which makes the aircraft vulnerable to SAMs and other threats.

NOTE: on some missions specially trained forces will be lasing targets from the ground, which means it will be possible to acquire targets and release weapons by looking through the HUD and steering towards the TIALD lock-box.

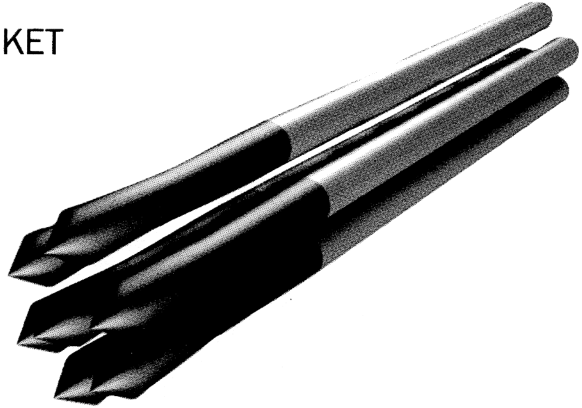
For more information on using the TIALD, see the TIALD section in AVIONICS.

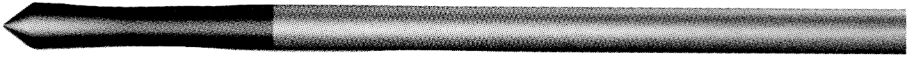
| **Bomb type** | **LGB** | **Free-fall** |
|---|---|---|
| 2,000 ft | 5 nm | 0.5 nm |
| 5,000 ft | 7 nm | 1.5 nm |
| 10,000 ft | 10 nm | 2.5 nm |
| 20,000 ft | 15 nm | 3.5 nm |

Typical ranges at different delivery altitudes

# AIR-TO-GROUND WEAPONS

## CRV-7 ROCKET





### DEVELOPMENT OF THE CRV-7 ROCKET

The CRV-7 rocket is Canadian in origin, and is a derivative of the unguided rockets first used in World War 2. Its principle application is ground-attack, and it provides a withering stream of destructive power which is as terrifying for those on the ground as it is deadly. It has a diameter of 70 mm and has been developed with a selection of warheads. Also built into the design is the ability to use differing propellants, giving the rocket advantage in aeroplane and helicopter firing situations.

The choice of warheads includes High Explosives, armour piercing, incendiary, penetrator, flechette, anti-tank and phosphorous markers. The range of these rockets can be up to 6 km and they travel at up to Mach 4 plus the launch speed of the aircraft. Impact speed is as high as 1250 metres per second. This makes the rocket a kinetic energy weapon, for example with the flechette anti-tank warhead. Flechettes are sharp darts made out of a tungsten alloy which makes them extremely hard. When the rocket is launched, five flechettes break free from the housing and disperse slightly before hitting the target. The energy of the impact coupled with the hardness of the flechette drives it straight through the armour, creating shrapnel which bounces around inside the tank. The penetrator warhead works on the same principle, letting the kinetic energy of the rocket drive a shaped penetrating rod through armour before detonating a high explosive incendiary device.

These weapons employ the same sight as the ground cannon, but do far more damage to ground targets. The number of rockets released depends on whether the player holds the fire button for continuous release, or simply clicks the trigger once for single rocket fire.

Because these weapons are more capable of destroying armoured targets than the cannon,

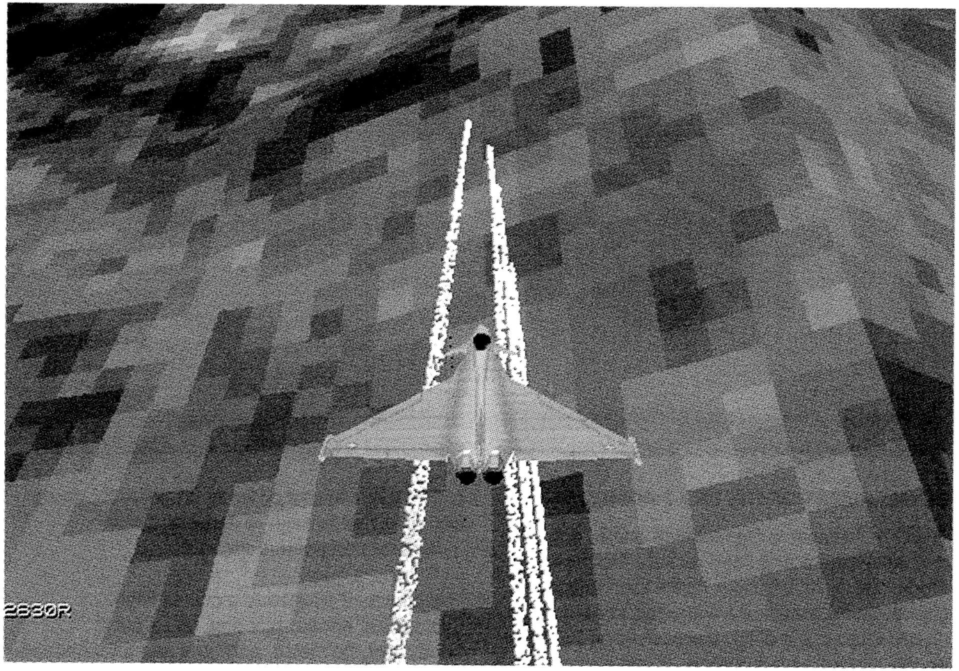
# AIR-TO-GROUND WEAPONS

## CRV-7 ROCKET

they should be chosen for the close air support missions. In case of emergencies, the cannon can be used though it will require greater skill to destroy the targets.

| | **CRV-7 ROCKET** |
|---|---|
| Length m | 1.5 |
| Diameter mm | 70 |
| Warhead kg | Various |
| Fuse | Various |
| Guidance | HUD predictor |
| Propulsion | Solid propellant |
| Range km | Up to 6 |
| Range miles | Up to 4 |

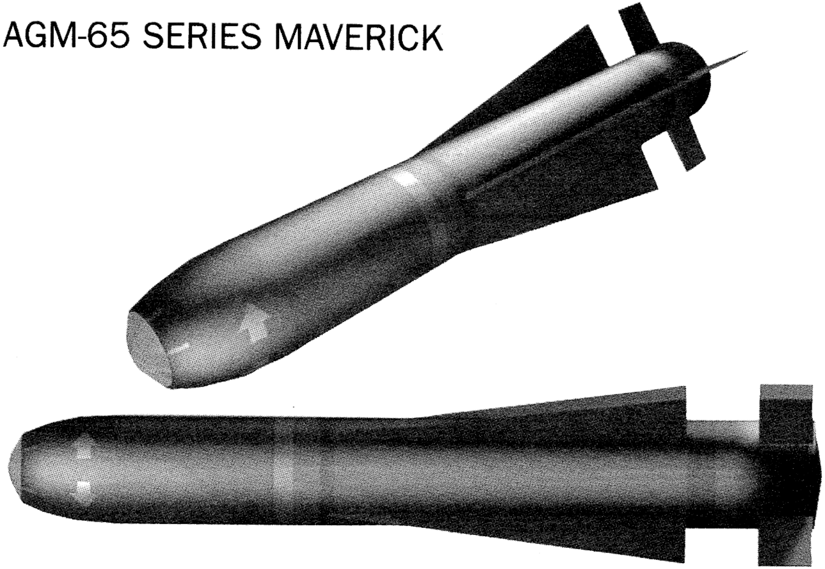
Performance Table



EF2000 firing the CRV-7

# AIR-TO-GROUND WEAPONS

## AGM-65 SERIES MAVERICK



### DEVELOPMENT OF THE AGM-65 SERIES

Guided missiles give attack aircraft the capability to put ordnance on the target without having to make dangerous bomb runs over or near to the target. Many guided missiles are specially designed for particular missions, such as destroying tanks, ships or radars.

Development of the Maverick started in the mid sixties with the first missile going into service in 1972. It saw service during the Gulf conflict, scoring an 80 percent hit rate. The USAF fired over 5,000 Mavericks, mainly at Iraqi tanks. There are four main versions, but the TV or electro-optical (EO) and imaging infra-red (IIR) versions are the most widely used and the latter is featured in EF2000. The TV version is aimed by the pilot who locates targets via a television camera in the missile's nose. The IIR version has superior night performance because its infra-red sensors show tanks as 'hot-spots'.

The quoted range of the Maverick is up to 25 miles (40 km) if released at altitude by a fast flying aircraft. However, experience shows that you need to be within 5 miles to pick up and identify your target. This is not such a problem for the slow-flying and armoured A-10s, but it may be too dangerous for the EF2000. For this reason, you will need to practise long-range targeting.

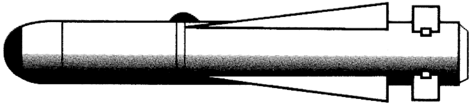
Maverick is ideal for taking out armoured vehicles, but can also be used as a precision weapon against targets such as parked aircraft, control towers, radar sites, SAM sites and communication centres. It is less useful against hardened targets.

# AIR-TO-GROUND WEAPONS

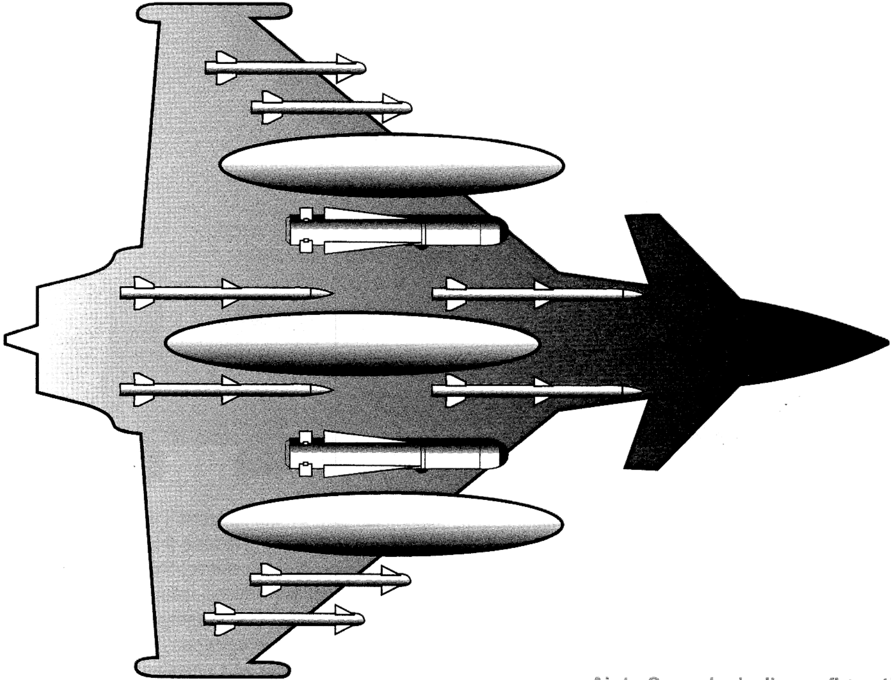
## AGM-65 SERIES MAVERICK

| | **AGM-65B** | **AGM-65D** |
|---|---|---|
| Length m | 2.49 | 2.49 |
| Diameter mm | 305 | 305 |
| Wingspan m | 0.72 | 0.72 |
| Weight kg | 210 | 220 |
| Warhead kg | 57.4 | 57.4 |
| Fuse | Impact | Impact |
| Guidance | TV | IIR |
| Propulsion | Solid propellant | Solid propellant |
| Range km | 3 | 22 |
| Range miles | 2 | 13 |

Performance Table



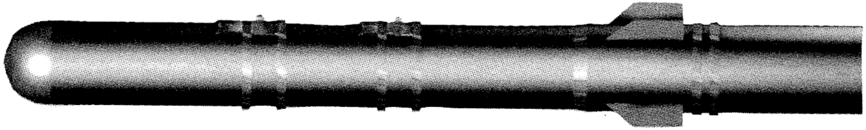
AGM-65 Maverick



Air-to-Ground missile configuration

# AIR-TO-GROUND WEAPONS

## DURANDAL ANTI-RUNWAY BOMB



### DEVELOPMENT OF THE DURANDAL

Designed in the early seventies, the Durandal was the result of the French airforce's requirement for a low level runway disablement weapon. The weapon had to penetrate the runway and explode beneath it to cause cratering and disruption to the area around the crater.

Durandal achieves its objectives using a unique delivery system. The missile is dropped in a low pass over the runway, it is then slowed by parachute to the correct delivery angle at which point a rocket motor ignites. The acceleration is enough to drive the specially shaped penetrating head through up to 400 mm of reinforced concrete. After a pre-programmed delay the missile explodes causing the paving slabs nearby to be disturbed.

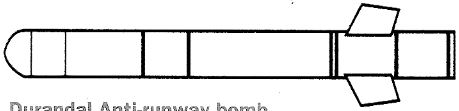
The nature of the weapon means that repair work can be hampered by unexploded Durandals as there is no way of telling when they will detonate. The damage a Durandal causes is also extensive and requires more than just earth-moving equipment to fill in the holes; all the paving slabs around the crater will need repairing. This makes the runway unusable for considerable lengths of time.

**APPLICATION**

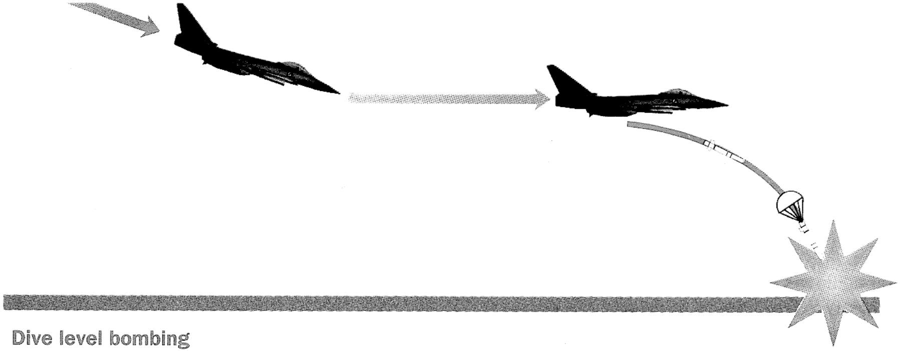
| | |
|---|---|
| Optimum Targets: | Runways |
| Poor Targets: | Bridges |
| Effective Range: | Nil |
| Max. Speed: | Retarded bomb |
| Attack Technique: | Low-altitude level bombing |
| Min Release Altitude: | 500' |

# AIR-TO-GROUND WEAPONS

## DURANDAL ANTI-RUNWAY BOMB



Durandal Anti-runway bomb



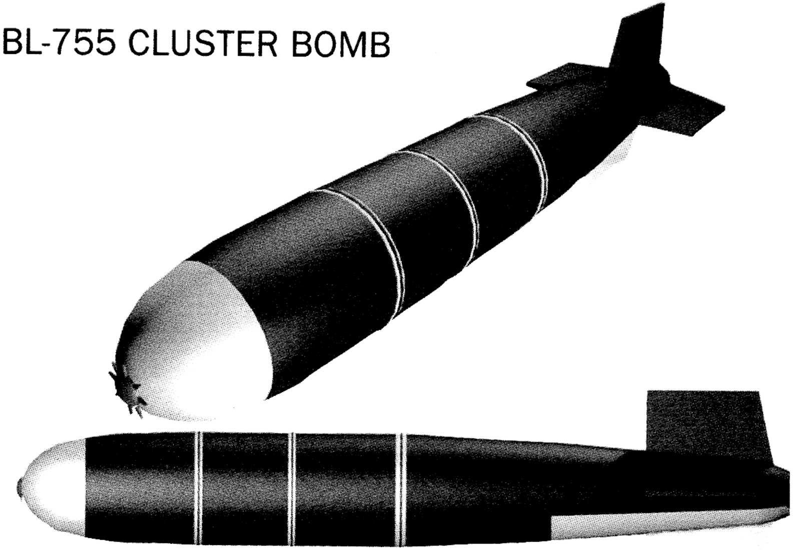
Dive level bombing

| | DURANDAL |
|---|---|
| Length m | 2.49 |
| Diameter mm | 223 |
| Wingspan m | 0.42 |
| Weight kg | 185 |
| Warhead kg | 15 |
| Fuse | Delay |
| Guidance | HUD predictor |
| Propulsion | Solid propellant |
| Range km | < 1 |
| Range miles | <0.5 |

Performance Table

# AIR-TO-GROUND WEAPONS

## BL-755 CLUSTER BOMB



### DEVELOPMENT OF THE BL-755

The BL-755 is a British designed cluster bomb which was originally developed in the sixties. A design goal for the weapon was to distribute a large number of sub-munitions over a wide area. This led to the development of a gas ejection system which, unlike earlier types, did not rely on centrifugal forces to eject the weapon. This gave the advantage of controllable delivery; each bomblet is ejected at a different velocity giving an even spread of sub-munitions approximately the size of a football pitch.

The BL 755 cluster bomb is carried by the EF2000, and once it falls to a pre-set altitude, it opens scattering hundreds of sub-munitions. Each sub-munition is designed to penetrate the weak top armour of a tank using a shaped charge. In addition, each bomblet scatters deadly red-hot shrapnel which is very effective in the anti personnel role.

In the Persian Gulf War, cluster bombs were used on a large scale. The results were devastating to the Iraqis, who christened the weapon 'Black Rain'. Around 26,000 Rockeye II cluster bombs were used by US forces in the conflict.

### APPLICATION

| | |
|---|---|
| Optimum Targets: | Grounded planes, missile sites, oil facilities |
| Poor Targets: | Bridges |
| Effective Range: | Nil |
| Max. Speed: | Retarded bomb |
| Attack Technique: | Low-altitude level bombing |
| Min Release Alt: | 100' |

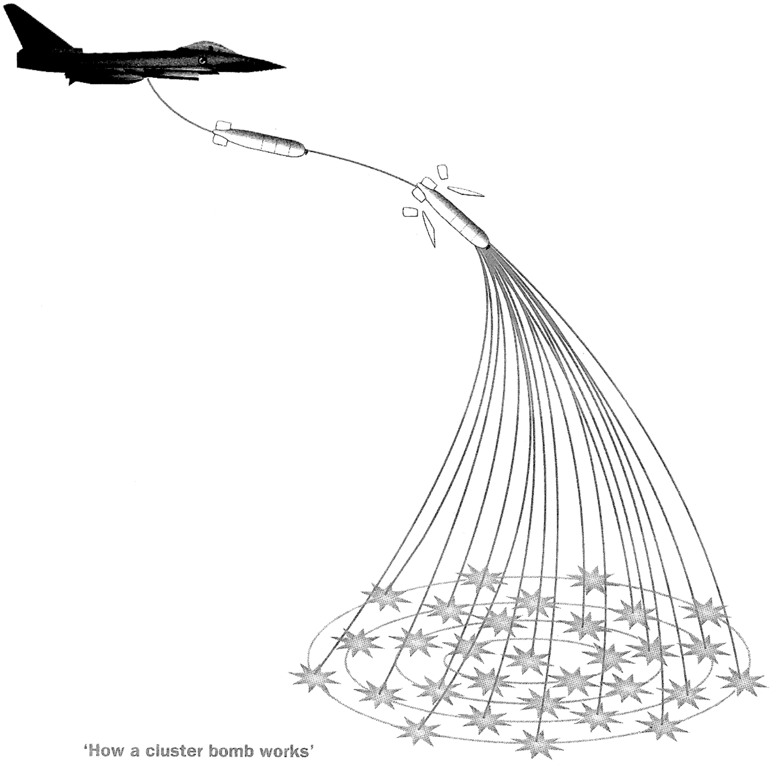
# AIR-TO-GROUND WEAPONS

## BL-755 CLUSTER BOMB

As often happens in war, pilots quickly found new applications for their weapons. For example, pilots found them ideal for destroying SAM and radar sites, which could not be attacked with anti-radiation missiles. Iraqi patrol boats and naval bases were also found to be suitable targets. In EF2000, you will find this is the only weapon to use against widely dispersed ground targets.

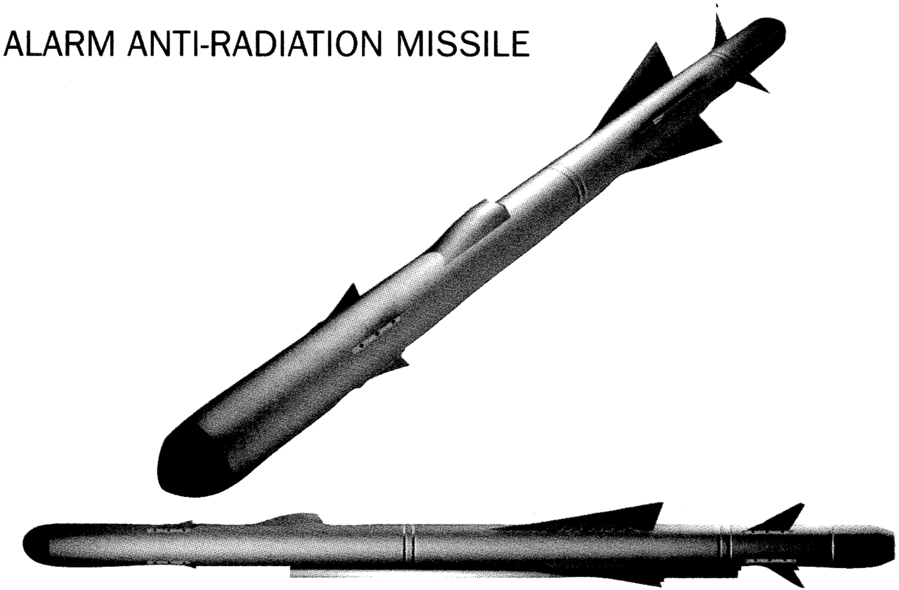
| | **BL-755** |
|---|---|
| Length m | 2.45 |
| Diameter mm | 419 |
| Wingspan m | 0.71 |
| Weight kg | 277 |
| Warhead | 147 bomblets |
| Fuse | Timed |
| Guidance | HUD predictor |

Performance Table



'How a cluster bomb works'

# ALARM ANTI-RADIATION MISSILE



### DEVELOPMENT OF THE ALARM

Anti-radiation missiles were developed during the Vietnam war as a way to strike back at SAM defences. They work by homing in on the radar emissions from SAM guidance systems, and are extremely effective. To counter them, SAM operators began the tactic of switching off their radars until the attacking aircraft has passed, then switching on again and firing. Later model anti-radiation missiles have been designed to counter this tactic, ALARM being one of the best examples.

The ALARM, or Air Launched Anti-Radiation Missile, was designed as a stand off multimode anti- radiation weapon that could be fired before the aircraft could get within range of the target's aerial defences. SAMs like the SA-6, the SA-N-9 and the SA-N-4 have ranges to about 15-20nm. ALARM can be launched from outside this range, it will then ascend to 40,000 feet from where it will deploy a parachute and descend slowly, using its seeker to search for any radiation source.

Once the target has been acquired, the missile releases the parachute and falls under gravity to the target. One other advantage with this system is that if the target shuts down before the missile has destroyed it, the missile remembers the location and will still hit the target.

ALARM also has several direct modes, the main one allowing the missile to be fired directly at the SAM once the emitter has been located. This is a very useful mode to use once the attacking aircraft is closing on the target, and there may be SAMs remaining that have not been destroyed by stand-off ALARMs.

# AIR-TO-GROUND WEAPONS

## ALARM ANTI RADIATION MISSILE

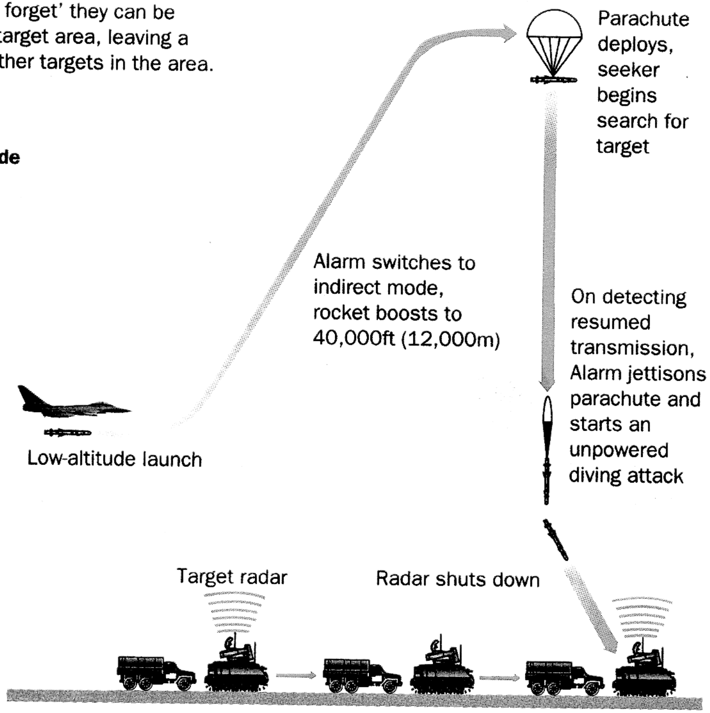
The key factor in determining attack altitude is the prevalence of SA-6s and SA4s around the target area. If there are many such weapons, a low-level attack could be the only kind possible. If there are SA-6s at the target itself, ALARM missiles should be carried and the radars attacked before the main strike force arrives. Fly in a flat formation for stand-off and low-level missions.

| | **ALARM** |
|---|---|
| Length m | 4.24 |
| Diameter mm | 224 |
| Wingspan m | 0.72 |
| Weight kg | 268 |
| Warhead | HE |
| Fuse | Active laser |
| Guidance | Passive laser |
| Propulsion | Solid propellant |
| Range km | 45 |
| Range miles | 28 |

Performance Table

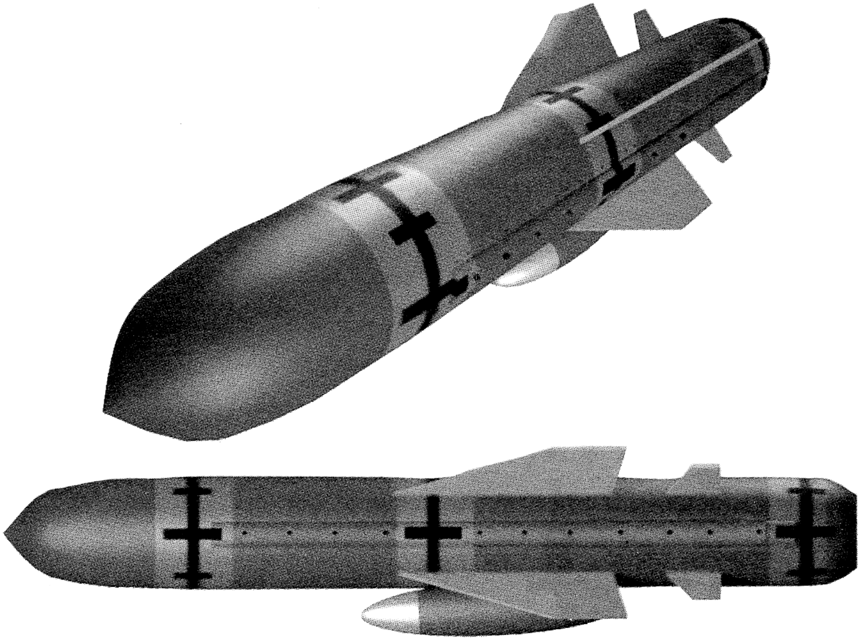
As the missile is 'fire and forget' they can be fired before reaching the target area, leaving a clear path to attack any other targets in the area.

**Alarm indirect attack mode**


Parachute deploys, seeker begins search for target
Alarm switches to indirect mode, rocket boosts to 40,000ft (12,000m)
On detecting resumed transmission, Alarm jettisons parachute and starts an unpowered diving attack
Low-altitude launch
Target radar
Radar shuts down

ALARM Indirect Attack

# SEA EAGLE ANTI-SHIP MISSILE



## DEVELOPMENT OF THE SEA EAGLE

The range of Air-to-Surface Missiles is steadily being increased to give better stand-off capability and hence better protection for launch aircraft. In this area, naval weapons are some of the most advanced because of the great distances involved in maritime warfare. Compared to the cluttered land battlefield, the sea provides ships and aircraft with very little protection from surveillance systems such as radar or thermal imaging.

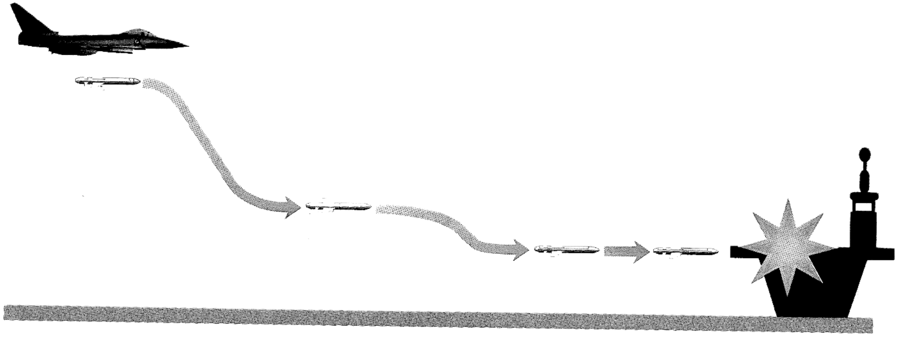
The Sea Eagle was developed in 1976, and was based on an earlier design of ASM. The difference was that the Sea Eagle had a turbofan engine, an active radar seeker and an altimeter, giving long distance sea-skimming ability. Sea Eagle approaches the target only a few feet above the waves to avoid detection by enemy radar and only illuminates the target with radar for confirmation of final guidance data. Computer data links also enable friendly surveillance aircraft to pass targeting intelligence to the missile in flight.

SAMs like the SA-6, the SA-N-9 and the SA-N-4 have ranges between 15 and 20 nm. The Sea

# AIR-TO-GROUND WEAPONS

## SEA EAGLE ANTI-SHIP MISSILE

Eagle anti-ship missile can be launched from outside this range. With 50 nm ranges, the SA-N-6 and SA-4 SAMs come close to the Sea Eagle's maximum range of 70 nm. Best launch altitude is relevant to target acquisition. You must be at least 2,000 ft above sea level before the ECR-90 radar will detect targets at maximum Sea Eagle range. The best launch altitude is that at which you can detect the target at the maximum range of the weapon, which would be 2,000 ft for the 70 nm range of the Sea Eagle. Fly in a flat formation for stand-off and low-level missions.



Typical stand-off delivery of Sea Eagle

### TARGETING SEA EAGLE

When you select this weapon, a special radar mode is set-up on MFD 1. The radar now shows seaborne targets at ranges of up to 80 nm. This mode is also capable of identifying surface vessel types and displaying them on the MFD.

| | **SEA EAGLE** |
|---|---|
| Length m | 4.14 |
| Diameter mm | 400 |
| Wingspan m | 1.2 |
| Weight kg | 600 |
| Warhead KG | 230 |
| Fuse | Delayed impact |
| Guidance | Inertial and active radar |
| Propulsion | Turbofan |
| Range km | 110 |
| Range miles | 68 |

Performance Table

# RUSSIAN WEAPONS

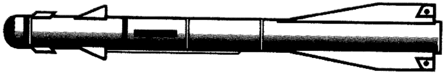
## WHAT THE OTHER SIDE WILL AIM AT YOU

The old Soviet Union had been developing its weapons for just as long as the Western powers, but up until a few years ago most information available was classified. Since the end of the Cold War however, the break-up of the Soviet Union has provided an opportunity for the emerging states to trade with the world in their own capacity. One of the results is that the information void surrounding the military has partly been filled. We can now estimate much more accurately how Russian weapons perform.

Most Russian weapons do the same job as their Western counterparts, and use similar technology.

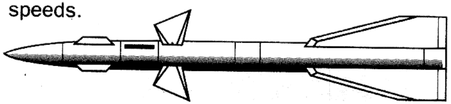
### AA-8 APHID

This is an all-aspect infra-red dogfighting missile, and the AA-8B variant in EF2000 has a range of about 16km. In performance, it is comparable with some of the later model Sidewinder missiles.



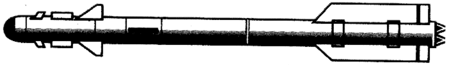
### AA-10 ALAMO

This missile comes in several forms. The most common is the medium range R27-R variant. Similar in operation to the AMRAAM the Alamo has semi-active radar only. It is also a larger missile with a bigger warhead. The range is similar to AMRAAM though the larger size would probably mean less manoeuvrability at higher speeds.



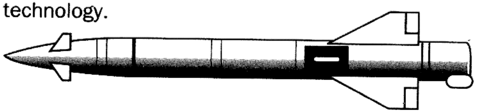
### AA-11 ARCHER

This is a short range Infra-red missile with a similar performance to the ASRAAM. Roughly the same size but heavier than ASRAAM, the Archer has a complex system of vectored thrust and fin control giving very high manoeuvrability. It also has the ability to be targeted using a helmet mounted sight.



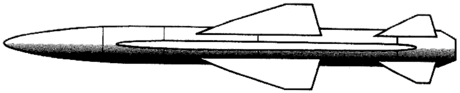
### AS-7 KERRY

The AS-7 is a command guided air to surface missile which is controlled by the pilot of the launch aircraft. Relying on the missile flare the pilot steers the missile to the target. This means that the pilot will have to be able to see the target, eliminating the stand off advantage afforded by western air to ground missile technology.



### AS-11 KILTER

This is a air to surface anti-radiation missile designed to destroy ground based radars. The KILTER does not have the same modes that ALARM has, but is a much bigger missile. The missile relies on passive radar to target and has a range of 70km.

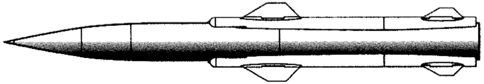


# RUSSIAN WEAPONS

## WHAT THE OTHER SIDE WILL AIM AT YOU

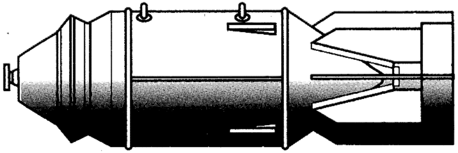
### MOSKIT

This has a similar role to the SEA EAGLE although the MOSKIT is a very big missile indeed. If released from altitude the missile may have a range of 250 km using active and passive radar to home in on its target.



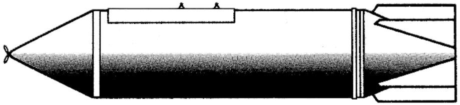
### FAB BOMBS

These are similar to the MK 80 Series 'iron bombs'. They are basic free-fall bombs in several sizes. The design varies and some of the older designs may have been upgraded with newer filling materials and fuses.



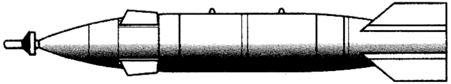
### RBK 500 SPBE CLUSTER BOMB

This weapon is primarily an anti tank cluster bomb. It contains 14 Anti-tank "smart" warheads which are released after the weapon has been dropped. The warheads fall by parachute and are triggered by Infra-red sensors. A shaped charge is fired at the target, penetrating the vulnerable top armour.



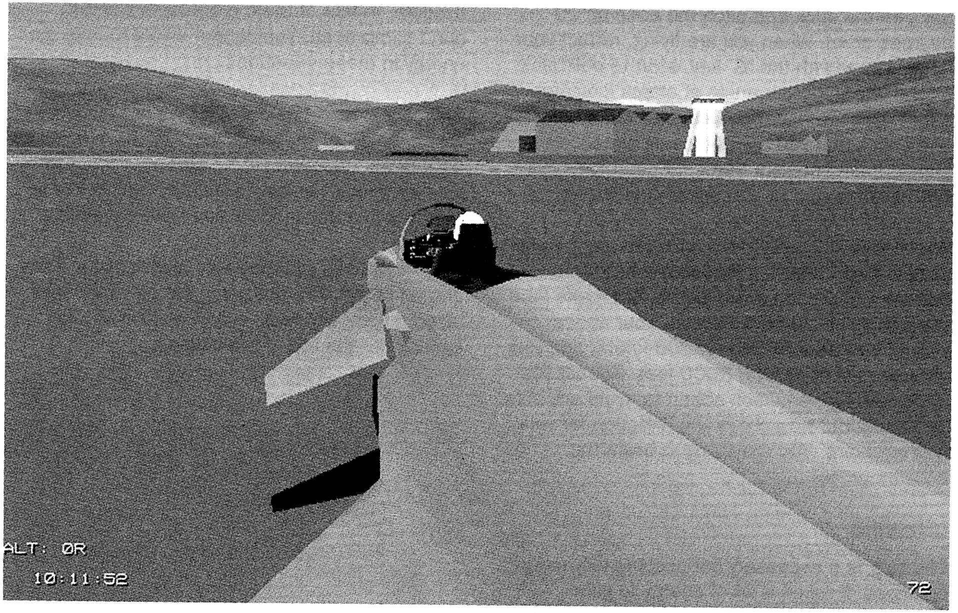
### KAB-500L LASER GUIDED BOMB

Apart from the general wing layout, this weapon is very similar to the Paveway bomb in many ways. The laser designator is usually built into the launch aircraft as opposed to a pod-mounting. Accuracy details are not known but the 500 kg bomb unit has a large destructive area.



# EF2000 FLIGHT TRAINING

## GENERAL FLYING & NAVIGATION TIPS



### TAXIING

To taxi from a dispersal point or the apron, fire up your engines and advance the throttle to 70% power. Steer using the < and > keys. Keep your ground-speed to below 20 knots by briefly applying your wheelbrake from time to time (key W). Do not attempt to take right angle corners at speeds greater than 10 knots, or the plane may tip over.

### TAKE-OFF

At the start of the flight you will find yourself at one end of a runway, with your engines off. Consider the following:

- If the runway is wet or icy, you require a longer take-off distance.
- If you have a full tank of fuel and a lot of stores, you require a longer take-off distance and a higher takeoff speed.
- If the wind is coming from your tail, you require a higher take-off ground speed.

## GENERAL FLYING & NAVIGATION TIPS

- If the wind is coming from in front, take-off ground speed will be lower. (It is always better to take-off into headwind.)

- If the wind is coming from either side, be careful.

You receive messages about taxiing and runway from the control tower. You will also hear communications that relate to changing radio frequencies after take-off. Normally, communication channels are pre-programmed on keys or 'studs' in the same way as modern car radios. Stud one is usually the frequency chosen for initial contact with the tower. Stud two is the regional frequency selected just after take-off, and stud three is the tactical frequency chosen when ten miles from the airfield.

Make sure wheel and airbrakes are off, then fire your engines. Increase throttle to 100 per cent, or apply afterburner for a quicker getaway. Remember, afterburner will consume large amounts of fuel, so cancel it at the earliest possible moment. As you move down the runway at increasing speed, maintain a straight-line. As the rotation speed of 120 knots is reached, pull back on the stick and pitch the nose up 20 degrees or so. When you are flying, retract your landing gear with the 'G' key. start to pull back on the joystick. Your angle of attack indicator should start to rise. Keep clear of the stall angle and check that you are not losing speed. You should soon see your Vertical Speed Indicator (VSI) start to rise as you become airborne.

Watch your VSI, and make sure you are gaining speed. If you aren't, increase thrust. If this doesn't work, pitch down a little, but make sure you don't start to lose altitude. Your speed should now be well clear of 200 knots, and your altitude should be over 1000 feet. Retract your undercarriage, and look ahead to avoid any hills or mountains. Now check the direction for your first waypoint. You are ready to begin the mission proper ...

### CLIMBING

Climbing is a necessary but occasionally risky business. It takes a lot of energy to gain altitude, and when you are in the climb, you are not so manoeuverable. It's best not to let your speed drop below 300 knots, otherwise even a simple break turn can take a little too long to execute. In fact, if there are missiles about, don't climb at all. You cannot afford to lose the energy in these situations.

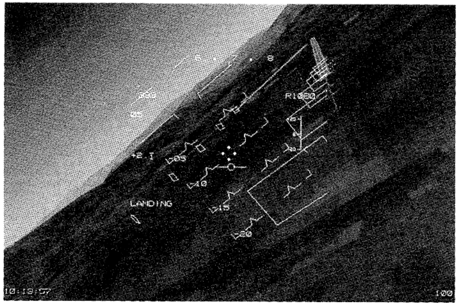
Climbing is made riskier still by a heavy load. In very dangerous situations you may have to dump all your air-to-ground stores (ALT J) in order to recover enough manoeuverability. Better live to fight another day than try and beat the odds.

When climbing, you may lose sight of your air or ground target. The answer is simply to roll over on your back and keep climbing. Now you're looking out the top of the canopy.

# EF2000 FLIGHT TRAINING

## GENERAL FLYING & NAVIGATION TIPS

### LANDING TIPS



Landing in any plane is a tricky business. You should learn how to execute a fully manual landing, because you may have a crippled plane to put on the deck. However, the autothrottle is a tremendous help for landing approaches. Set this to 150 knots and activate it during descent.

Fly at 10,000 feet to within 25 miles of the airfield. Dump any excess stores by pressing ALT 'J'. Press I to activate ILS and the Command Flight Path Display, which shows a virtual corridor in the sky extending from the runway. Head for the nearest box and align yourself so that you are flying down the corridor. Keep a close eye on your airspeed, and make sure that your velocity vector does not drop below the CFPD boxes. With skill, you should arrive on the runway at an ideal velocity and rate of decent. Cut the autothrottle just before touchdown, so you can drop the RPM quickly.

When landing without CFPD assistance, try to keep your velocity vector on the end of the runway. Remember, in an approach you use throttle to adjust altitude, and pitch to adjust speed.

### HANDLING A DAMAGED PLANE

EF2000 simulates damage to your aeroplane, making it difficult to fly and land. Although the fly-by-wire system will do its best to compensate for damage, the aircraft may oscillate in the worst cases. If this happens, reduce your airspeed. It is possible to get an unstable plane down on the runway, but this requires you to use stick to counter the movements. In all emergency cases, get rid of all weapons as quickly as possible, because you need all the power you can get plus minimum drag.

Check the MFD to see what critical systems have been damaged. For instance, if it's your landing gear, then there's no option but to eject or try a belly landing - just make sure you're over friendly territory when you go. If you lose weapons control and radar, you can't fight but you can still navigate home. Drop down low and use the map to steer yourself home.

### FLYING AT NIGHT

The EF2000 was designed as a night bird. However, night flying has its problems. Pilots have died simply because they became spatially disoriented (they didn't know which way up they were). For this reason, EF2000 pilots are equipped with the latest Night Vision (NV) image enhancers. This works by detecting the photons in available light, and amplifying their brightness to produce the characteristic green NV image. Press the key 'V' to access this mode when flying at night-time.

### LEVEL FLIGHT

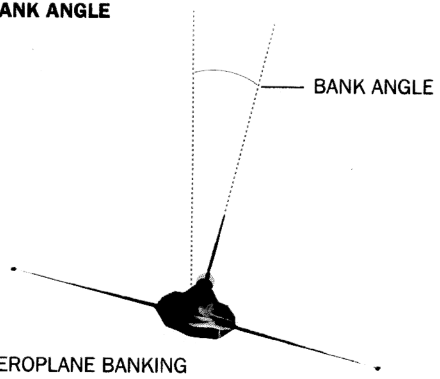
To fly at constant altitude in a constant direction, your wings must be level. Check this by looking from the front of the cockpit to the horizon. If your wings are level, then the horizon will be flat. In addition, your velocity vector should be exactly in-line with the widest bar of the pitch ladder, which represents the horizon.

Next, ensure you are in air-to-ground mode (press backspace) and check your VSI. This is the scale in the top right corner of the Head-Up Display (HUD). The line extending up or down from the zero mark shows the change in altitude in feet per second. To fly at a constant height, you want this reading to be about zero. If it is negative, pull gently back on the stick. You will see the horizon appear to fall as the aircraft's nose rises. How fast this change occurs will depend on how far you moved the joystick. If your VSI has a positive reading, then the same applies, but push the joystick forward.

### TURNING

Although turning is only a horizontal change of direction, aeroplanes can only perform flat (unbanked) turns at low speeds. Normally, the rudders cannot be used simply to turn the aeroplane's nose towards a different heading. Aeroplanes have much more control in pitching (up-down rotation), and so turns are made by changing a yawing (sideways turning) motion into one involving pitch. This is done by banking the aircraft, that is, by raising one wing and lowering the other.

**BANK ANGLE**



AEROPLANE BANKING

To make a turn, you must bank the aircraft so that your desired direction is above your nose. So, push the joystick sideways for a second, then release it. The aircraft will bank and your nose should slowly begin to edge below the horizon as you yaw into the turn. Now, pull back on the joystick so as to keep your nose level. You are now executing a level turn. The more you bank, the faster you will be able to turn with a level nose.

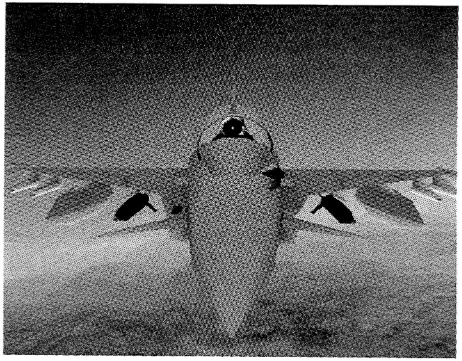
While turning, you are now using only part of your lift to keep the aircraft up. The rest of your lift is changing the direction of your aircraft's movement. Aerodynamic stability makes sure that your aircraft's nose does not stray to far from this direction at any time. Obviously, as only part of your lift is balancing out your weight, you need more lift in total to stay up. When lift is different to weight, you begin to feel the effect of the resulting acceleration. This is called G-force.

### REFUELLING

As if landing was bad enough, we chose to put an equally difficult manoeuvre in the program: mid -air refuelling. A lot of practice will be needed to perfect this, so go to the basic training section of the simulator. First, select 'Request Refuel' from the 'Flight comms' menu. You will be told which hose to use. To help you navigate to the refueller, press SHIFT ' to bring up the refuelling mode HUD. This will give you a track box on the refueller and show your closing velocity. Data on time to tanker and altitude are given in the lower right-hand side of the HUD. In the full cockpit view, press key ' to extend the refuelling probe. The objective is simply to insert this into the basket and keep it there. Approach the tanker with a closing velocity of plus 50 knots and use your airbrake to modify your speed. You can also set the autothrottle to match the refueller's speed to make things easier. Apart from that, you will have to be good to succeed. If you are finding refuelling too difficult in missions, simply press the event skip key (SHIFT S) to bypass it. You will be refuelled automatically in the process.

# EF2000 FLIGHT TRAINING

## COPING WITH GRAVITY - THE BIG 'G'



Now you weigh 1,500 pounds!

If you really want to know just how much hard work is involved in flying a fighter plane, use the full 'G-LOC' (Gravity induced Loss Of Consciousness) option in the options menu. Not only does it black-out your vision in tight turns, but it is the first to simulate how breathing sounds at high Gs. Through your PC speakers it's painful to hear - but who said G forces are pleasant?

Turning hard loads the plane with extra G forces. One G is the norm, but a modern fighter can quickly reach the limit for a fit pilot. . . around nine Gs. That means your 160 lb body suddenly weighs around 1500 lbs. Ouch! What's more, your blood no longer wants to go upwards into your brain, but prefers to collect in you feet. This leads to swollen ankles, varicose veins and a black-out, which may last long enough for you to die at the hands of your enemy or hit the ground.

The opposite of black-out occurs when you suddenly drop your plane's nose and the blood rushes to your head. As a result, your eyelids close involuntarily, causing 'red-out'. It happens with just a few negative Gs, and in practise, you should never deliberately execute manoeuvres that cause it.

The EuroFighter is equipped with a 'G-limiter', which prevents the plane turning at more than 9 G. However, a breakthrough mechanism is incorporated which enables a fit pilot to exert 40 pounds of pressure on the stick to break through the G-limit. Experiments are currently under way to force air into the pilot in order to increase his G tolerance. These 'pressure breathing' suits are able to raise G resistance to around 12 G or 13 G for short time, but pilots suffer from burst minor blood vessels throughout their body.

In contrast to plane and pilot, advanced AA missiles like ASRAAM will be able to pull 30 G plus manoeuvres, but don't worry too much. A missile pulling 30 G at Mach 4 can be easily out-turned by a plane pulling only 4 G.

## COPING WITH GRAVITY - THE BIG 'G'

| SPEED IN KTS | SECONDS FOR A 180 DEGREE TURN AT 4G | SECONDS FOR A 180 DEGREE TURN AT 9G |
|---|---|---|
| *400* | **16** | **7** |
| *450* | **18** | **8** |
| *500* | **20** | **9** |
| *MACH 1* | **26** | **12** |

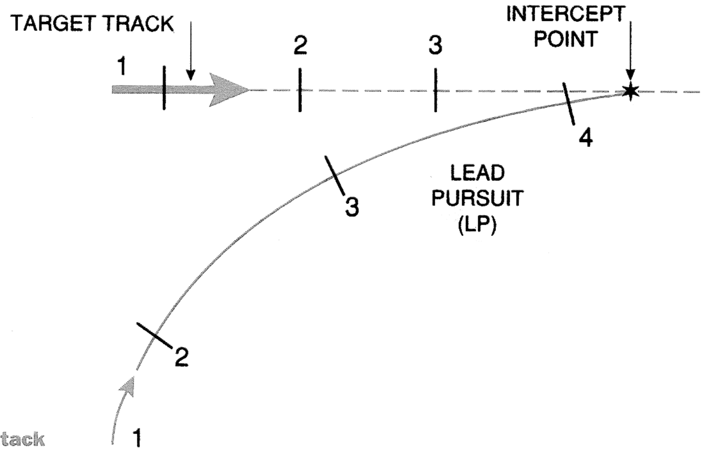
Together with your air-speed indicator, the G-meter in the HUD indicates how fast you are turning. This table illustrates a variety of combinations.

**Modern G-suit**

G-suits are designed to stop blood pooling in your feet or brain by squeezing key parts of the body tightly. In some modern fighters, the seat is also reclined so that the pilot is not sitting at right angles to the forces of acceleration that induce the G-effects.

# AIR-TO-AIR COMBAT

## WEAPON TACTICS



Target attack

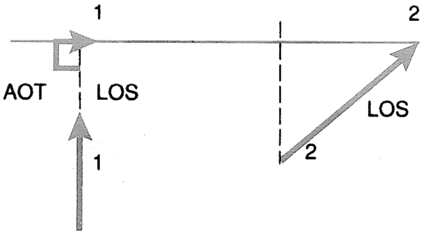
### USING CANNON

The modern fighter pilot has an exceptional arsenal of weaponry for air to air combat. The weapon you use will determine the way you fly. Only by putting the aeroplane within aiming parameters will you be able to defeat your enemy. Only by denying your opponent these parameters will you be safe.

The oldest weapon, the cannon, is rarely used today, but is the last line of defence when the more complex missiles have (as is often the case) failed to eliminate the threat. Mounted close to the centre of mass for minimum impact on flight path, the fighter cannon shoots explosive shells in the direction the aeroplane is pointing.

### ATTACK

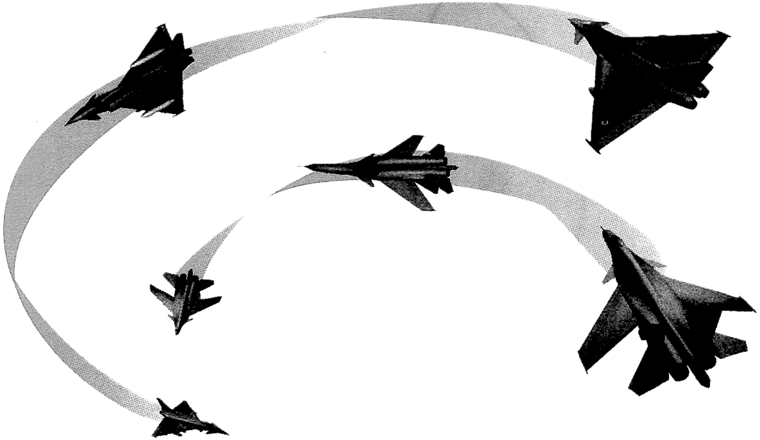
To hit a moving target, the fighter must shoot at where the target will be when the shells intersect the target's flight path, using lead pursuit (pointing ahead of the target).



Approaching abeam

The gunsight pipper helps to calculate lead, but only with low AOT (angle off-tail) can the fighter have a reasonable chance of a hit. Approaching from the side ('abeam' the target) at about 90 degrees AOT, the fighter must keep turning to maintain a steady target in his sights, because the line of sight (LOS) to the target is changing rapidly.

With low AOT, even with a manoeuvring target, LOS rate is low, and a good tracking shot is



Guns attack from abeam, followed by break turn

easier to obtain. If unable to obtain a steady LOS, the snapshot may be a better option. This involves taking the opportunity of a shot when the target passes through the pipper, but lead is much harder to calculate.

**DEFENCE**

The key to guns defence is to offer your opponent a high LOS rate and a high AOT. The diagram on this page shows the bandit moving in from abeam for a tracking shot. The bandit turns towards the fighter as AOT decreases. Noticing the threat, the fighter rolls left and pulls towards the bandit. Continuing to turn in this direction would offer the bandit an excellent snapshot, so the fighter rolls further left and pulls into the vertical plane. This change of manoeuvring plane unbalances the bandit, who must rethink his attack.

## WEAPON TACTICS

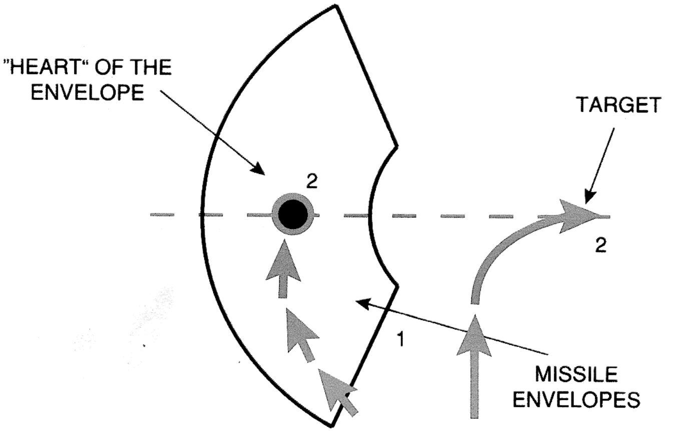
### USING MISSILES

IR Missiles come in two types. The older heat-seekers (Infra-Red guided missiles) are rear-aspect weapons, which need to be behind the target to home on the hot tailpipe. More recent IR missiles have been able to track hot exhaust gases and the warm aircraft body, even from head on or abeam.

Radar guided missiles are all-aspect, and work best at angles which maximize the radar signature. These also come in two types. The Semi-Active Radar Homing (SARH) missiles, such as Sparrow and Skyflash, home on reflected radar signals bounced off the target from the launching fighter. The newer missiles, like AMRAAM, are fire-and-forget, like the IR guided types. These have their own radar transmitters, allowing the fighter to turn away after launching.

### ATTACK

The missile type will determine the required offensive manoeuvres for the fighter. The firing envelope for rear aspect missiles is shown in the diagram on this page.



Firing envelope

Using pure pursuit (pointing directly at the target) can cause the fighter to get too close to the target. To keep out of minimum range, lag pursuit or pointing behind the target is best. As the fighter approaches the heart of the envelope, turn rate should increase towards pure pursuit before launch.

Some modern missiles like ASRAAM can be fired off-boresight, using helmet-mounted sights.

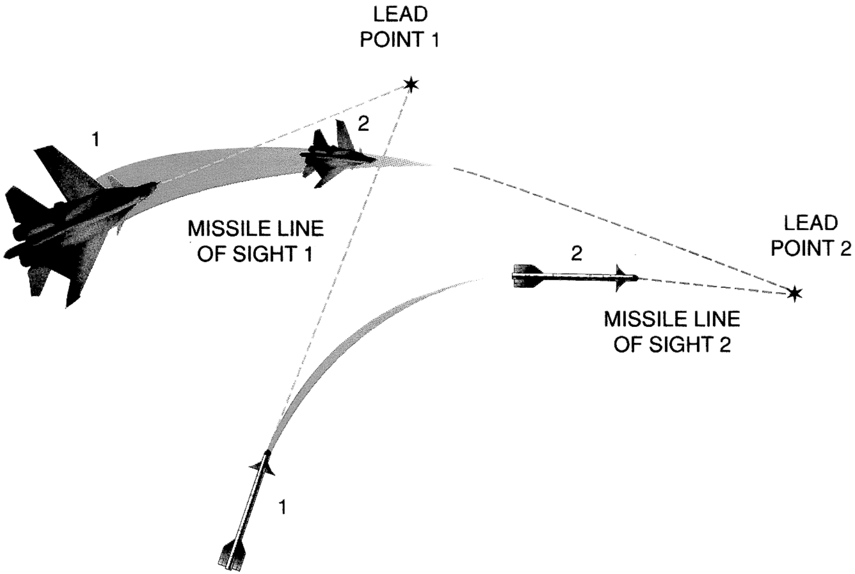
## WEAPON TACTICS

However, even modern all-aspect, off-boresight missiles perform best when launched like other missiles.

### DEFENCE

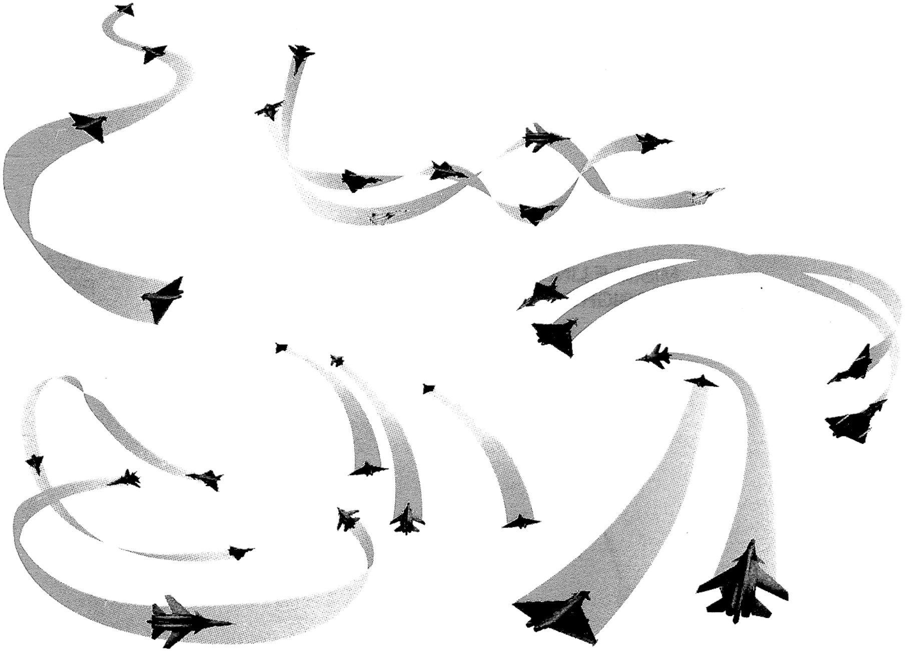
The fighter should avoid presenting either bandits or SAMs with the opportunity for a missile launch. The best defence against a missile approaching from abeam is a sharp break up or down. This is because the missile will use lead pursuit, following a point ahead of the target's nose. So a change in the pointing direction of the target makes a big difference to the missile's aiming point.

If a missile is approaching from ahead or behind, the fighter should break hard to present a beam aspect and follow the procedure above.



Missile leading from abeam on breaking target

## BASIC FIGHTER MANOEUVRES



Combat tactics

### BASIC COMBAT TACTICS

Contrary to popular belief, fighting in a modern jet aircraft is not just a push-button affair. It is true that these days the fight begins over the horizon, using AWACS, radar and smart missiles. But the enemy may survive this high-tech phase of combat, and quickly close to the kind of ranges where pure skill and nerve replace micro-chip and sensors. Remember, in many cases the opposition is as highly trained as Nato pilots, and they also have the same goal in their mission - to shoot-down anyone they meet.

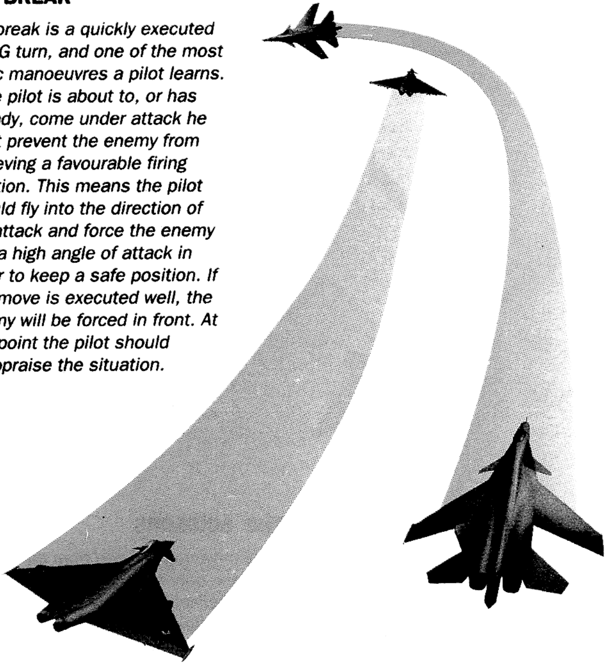
A close-in dogfight often takes on the appearance of a ritual dance, each pilot using all the techniques in his repertoire to out-smart the opponent. This has led to standard manoeuvres being developed for aerial combat. These are learned by all pilots, who will attempt to perfect every aspect of timing and positioning. The outcome will be pilots who can face the enemy in an even fight, and be reasonably sure of winning. The basic manoeuvres are fine if executed well but in an unfair fight there is little option than to retreat and regroup. All aspects of combat need to be perfected if a pilot is to be successful and long-lived.

# AIR-TO-AIR COMBAT

## BASIC FIGHTER MANOEUVRES

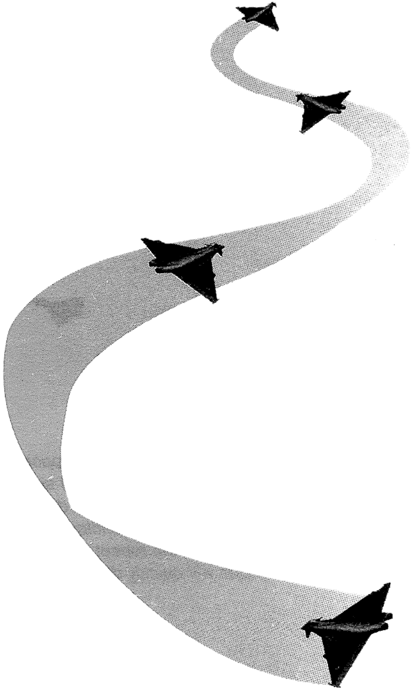
### THE BREAK

*The break is a quickly executed high-G turn, and one of the most basic manoeuvres a pilot learns. If the pilot is about to, or has already, come under attack he must prevent the enemy from achieving a favourable firing position. This means the pilot should fly into the direction of the attack and force the enemy into a high angle of attack in order to keep a safe position. If this move is executed well, the enemy will be forced in front. At this point the pilot should re-appraise the situation.*



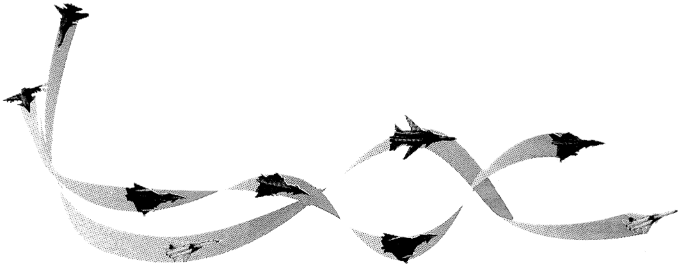
### SLOWING FORWARD VELOCITY

*In order to force an opponent to take the lead the plane must slow down. This is achieved by using the air-brake and snaking the aircraft from side to side. The violent action slows the plane, and the snaking path is a longer distance to travel. This kind of action forms the basis of the scissors manoeuvre.*



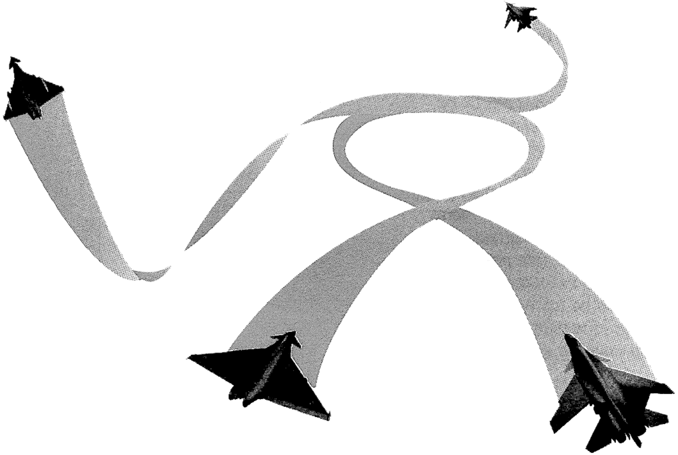
# AIR-TO-AIR COMBAT

## BASIC FIGHTER MANOEUVRES



### THE SCISSORS

*If the break is successful, the pilot will want the opponent to be forced into an undesirable position. The scissors manoeuvre will slow the plane's velocity in a certain direction. Each pilot will be attempting to do the same thing so the victor will be the pilot with the best timing and technique. One wrong decision in this manoeuvre is bad news. The pilots will repeat the scissors a few times and then break because their airspeeds will quickly diminish.*



### BREAKING THE SCISSORS

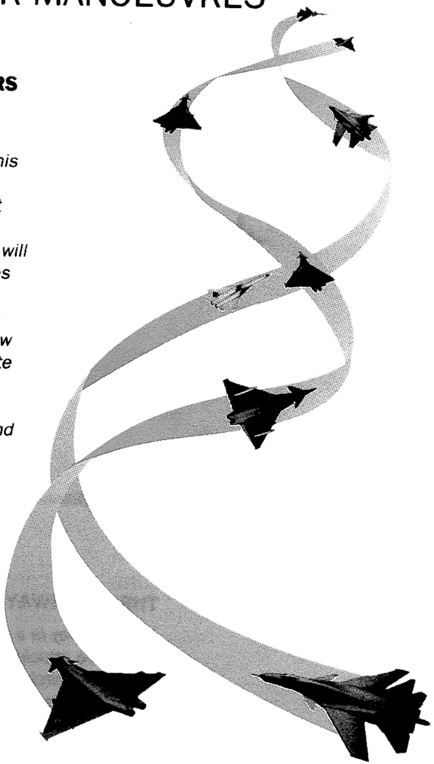
*If there is no clear advantage gained from the scissors then the next option is to get out without any loss of tactical position. The pilot makes a reversal then heads straight toward the enemy. After diving away the pilot then rolls upright and can head into the sun, leaving the opponent to turn around to try and re-acquire his target.*

# AIR-TO-AIR COMBAT

## BASIC FIGHTER MANOEUVRES

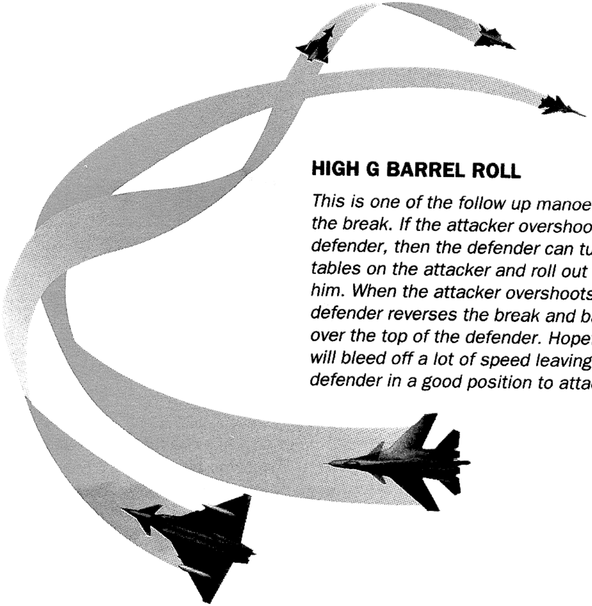
### THE VERTICAL SCISSORS

*The scissors may also be performed vertically, either upwards or downwards. In this case the reverses take the form of barrel rolls. The pilot who enters this manoeuvre with the higher energy state will lose advantage as the planes are slowed by gravity. In a diving scissors the defender should position himself below the enemy so he may execute a Split-S manoeuvre and escape. The Split-S lets a defender roll upside down and dive away and pull out in the opposite direction.*



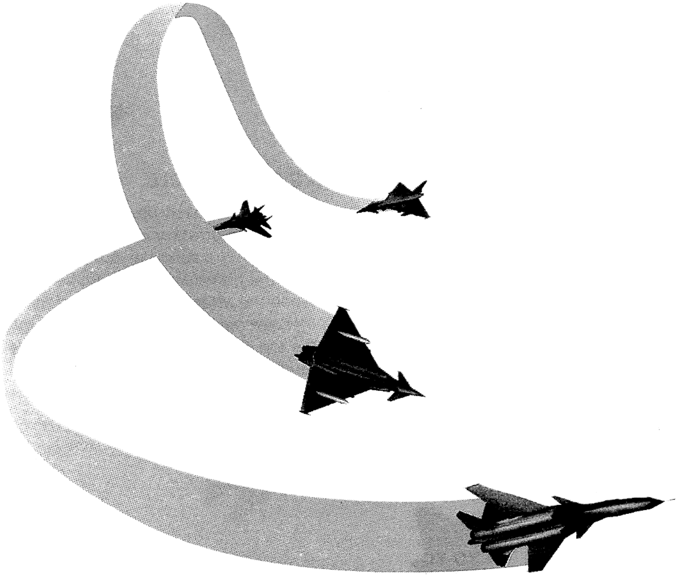
### HIGH G BARREL ROLL

*This is one of the follow up manoeuvres to the break. If the attacker overshoots the defender, then the defender can turn the tables on the attacker and roll out behind him. When the attacker overshoots, the defender reverses the break and barrel rolls over the top of the defender. Hopefully this will bleed off a lot of speed leaving the defender in a good position to attack.*



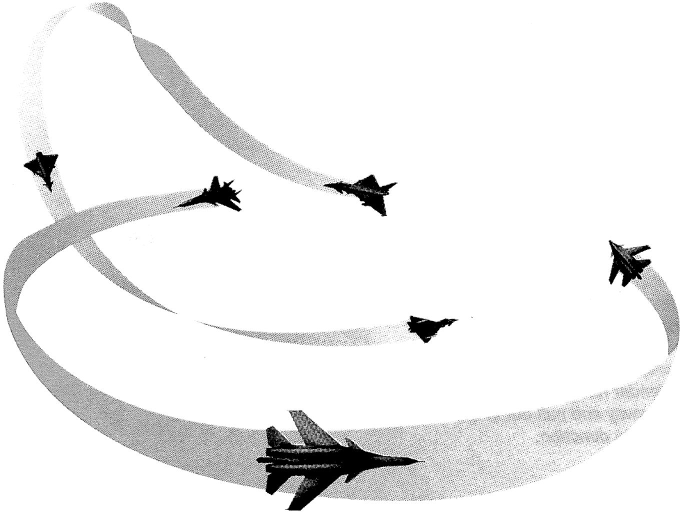
# AIR-TO-AIR COMBAT

## BASIC FIGHTER MANOEUVRES



### HIGH YO-YO

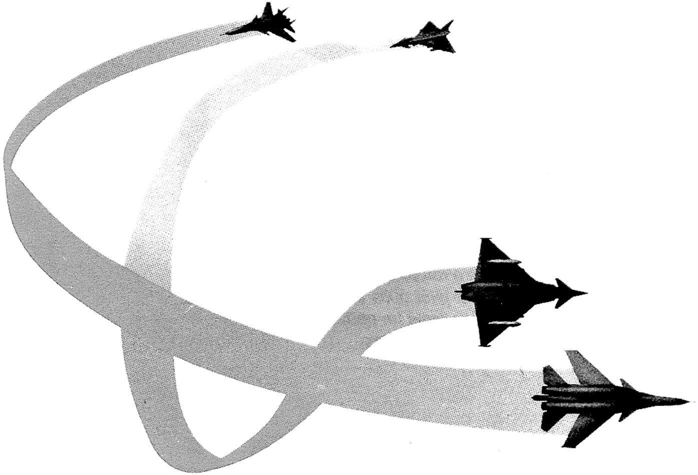
*If the opposition forces you to overshoot with one of the examples previously described, then you may be able to counter in several ways. The high yo-yo allows the pilot to use gravity to avoid overshooting. As the defending pilot breaks, the opponent pulls back and rolls over in effect cutting the circle and dropping in behind the enemy.*



### THE ROLLAWAY

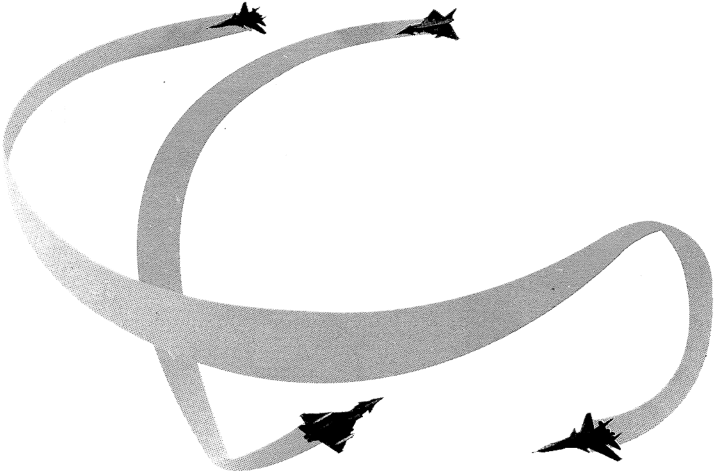
*The rollaway is a variant of the high speed yo-yo where the attacking pilot pulls up but instead of cutting the circle, he instead rolls the opposite way. When he is level again he will be in a position to pick up the opponent and drop in behind him.*

## BASIC FIGHTER MANOEUVRES



### THE LOW YO-YO

*This is a similar manoeuvre to the high yo-yo except that it is used when the attacker doesn't have enough speed to reach an opponent. The pilot rolls upside down and dives across the circle, trading height for speed and catching up to the enemy. This method can be employed when the defending aircraft is running away. The attacking aircraft starts a shallow dive and catches up to his opponent. When close, he will be in the enemy's blind spot.*

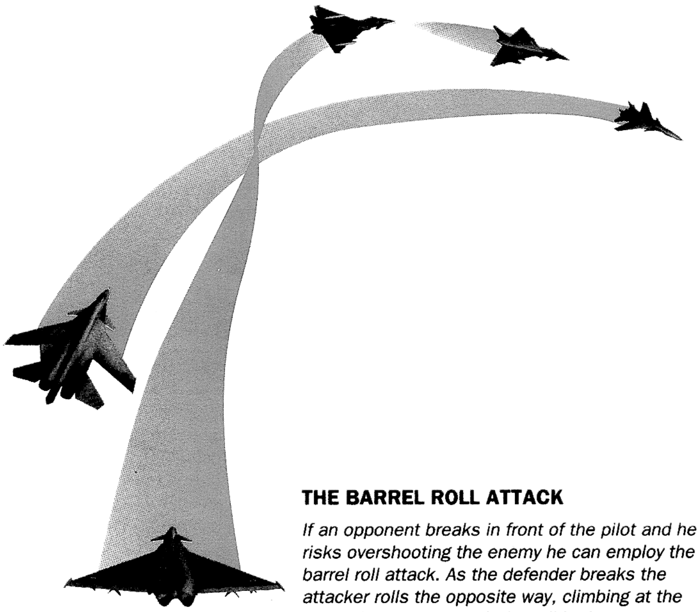


### THE COUNTER LOW YO-YO

*There is a standard counter to the low yo-yo. After the attacker dives down to cut across, the defender pulls up and rolls the opposite direction. When he pulls level he will be heading towards the attacker ready to make another move.*

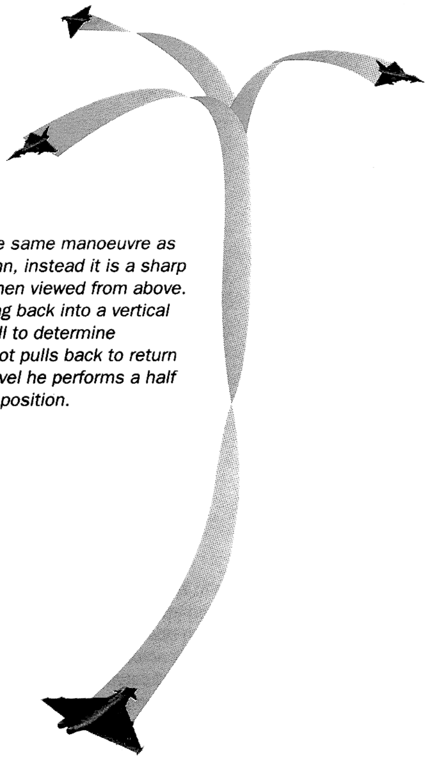
# AIR-TO-AIR COMBAT

## BASIC FIGHTER MANOEUVRES



### THE BARREL ROLL ATTACK

*If an opponent breaks in front of the pilot and he risks overshooting the enemy he can employ the barrel roll attack. As the defender breaks the attacker rolls the opposite way, climbing at the same time so as to exit the roll in the same direction as the opponent but still with tactical advantage. Countering this means diving away and looking out for missile attack.*



### THE IMMELMANN

*This is not actually the same manoeuvre as the original Immelmann, instead it is a sharp change of direction when viewed from above. It is achieved by pulling back into a vertical climb followed by a roll to determine direction. Then the pilot pulls back to return to level flight. Once level he performs a half roll to recover upright position.*

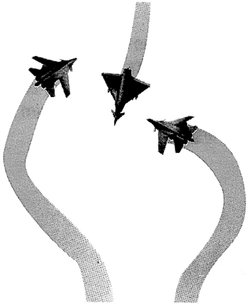
## SECTION MANOEUVRES

### DOUBLE ATTACK

Fighters most often work in sections, which comprise a section leader and his wingman. In WWII, they would move as a fighting wing, the wingman sticking close to his leader's tail. In engagements, the leader fights as a singleton; his wingman is a second pair of eyes, sometimes offering extra firepower.

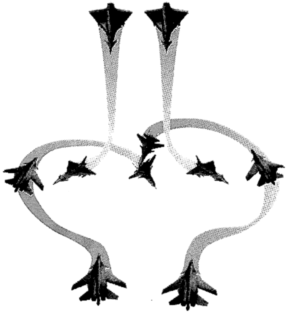
Although fighting wing doctrine is still used today, the preferred system is the double attack. Cruising in combat spread for mutual protection, the section engages, and whichever of the fighters is in the best tactical position attacks. The engaged fighter manoeuvres for a kill, while the other, free fighter, orbits close to the fight. During the fight, the engaged fighter is effectively the section leader. The free fighter should watch his partner's tail, keeping a higher altitude for energy advantage. When the engaged fighter feels in danger of losing the offensive, he will command the free fighter to engage and the pair will swap places.

The result of this system is that the wingleader-wingman relationship becomes fluid, and the fighter with the offensive advantage will be in effective command.



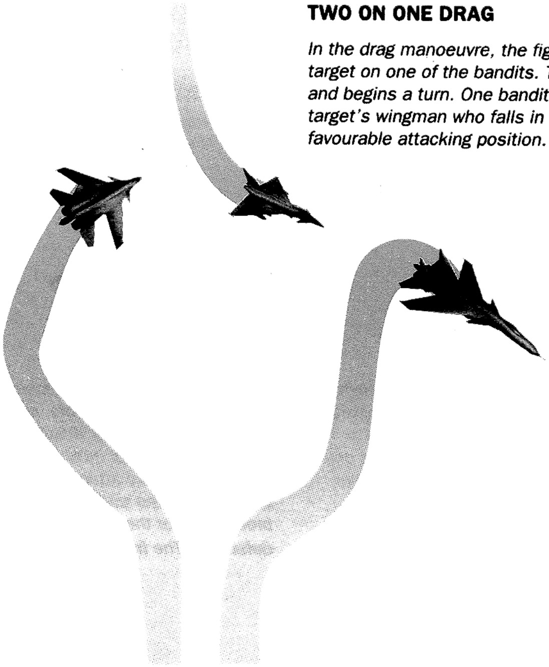
**TWO ON ONE BRACKET**

*The bracket is a form of offensive split. The two fighters break in opposite directions and reverse back towards each other. The manoeuvre forces a lone enemy to make a choice of target, and as he turns towards one fighter, he leaves his tail open to attack by the other.*



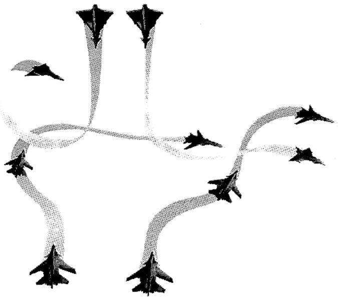
**TWO ON TWO BRACKET**

*Against two bandits, the bracket can put both on the defensive. Splitting too late, each bandit chooses a target, and is promptly attacked on the tail by the other fighter. However, for both fighters to press the attack is contrary to double attack doctrine, as it leaves them vulnerable to the wild-card bogey. One fighter should break to cover the other's attack while both bandits are defensive. The free bandit can be dealt with later.*



### TWO ON ONE DRAG

*In the drag manoeuvre, the fighters attempt to force a target on one of the bandits. The dragger moves ahead and begins a turn. One bandit follows, unaware of his target's wingman who falls in behind him in a favourable attacking position.*

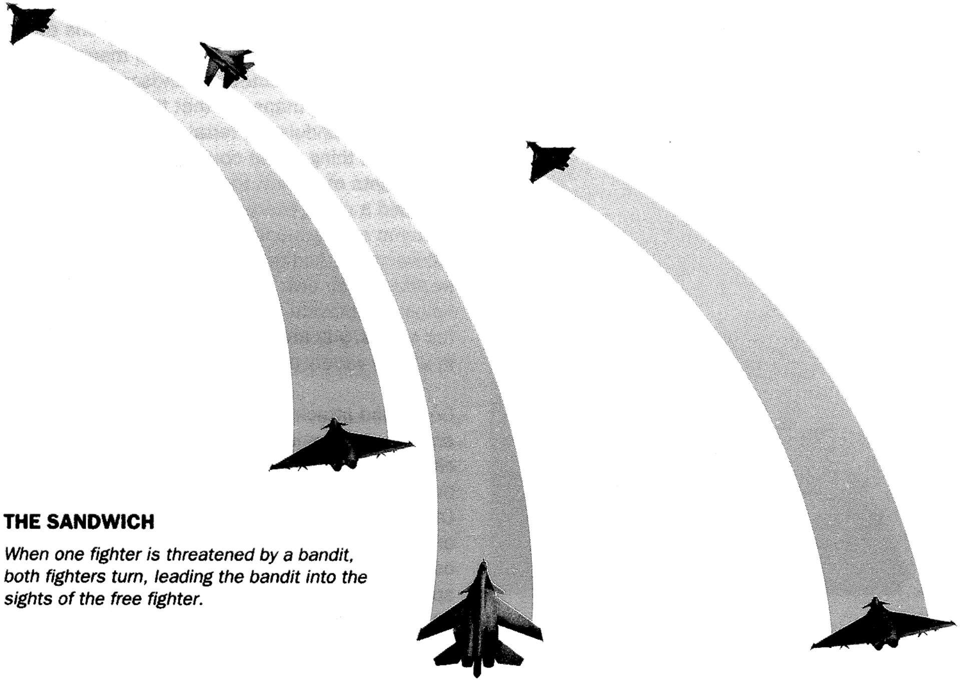


### TWO ON TWO DRAG

*The following diagram shows a combination manoeuvre in a 2 on 2 engagement. Starting a bracket to split the bandits, the fighters then initiate a drag manoeuvre. The left hand fighter makes a head on pass across the nearest bandit to back up the dragger on the right. As the right hand bandit chases an easy target his partner sees the danger, but cannot make the about turn necessary to prevent the trap being sprung.*

# AIR-TO-AIR COMBAT

## SECTION MANOEUVRES

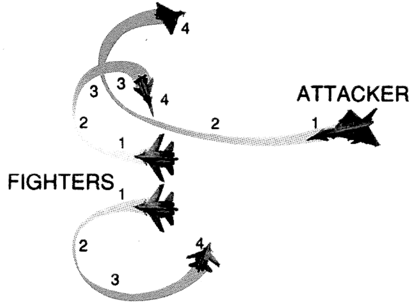


**THE SANDWICH**

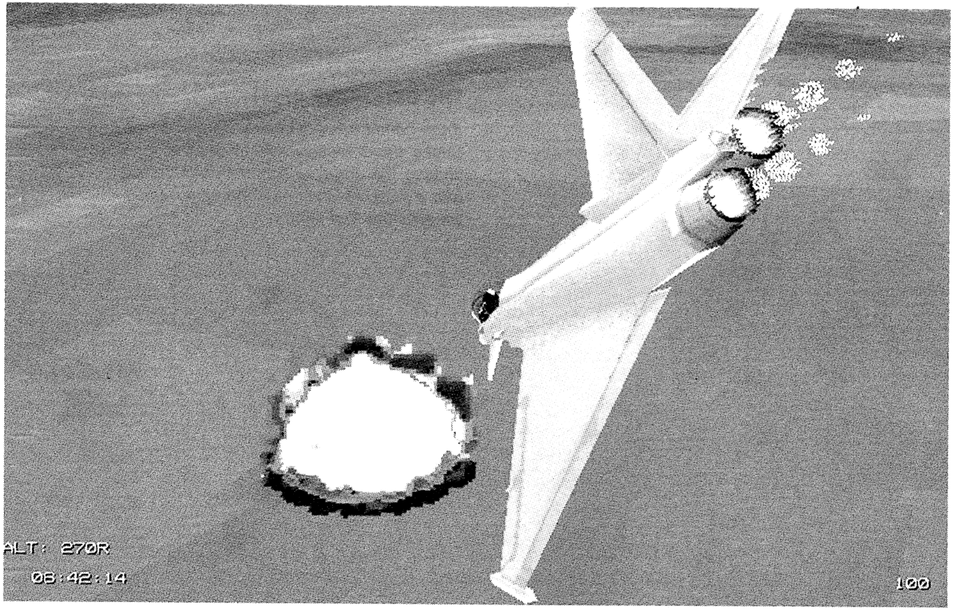
*When one fighter is threatened by a bandit, both fighters turn, leading the bandit into the sights of the free fighter.*

**THE DEFENSIVE SPLIT**

*If the bandit has not clearly chosen a target, the defensive split forces the choice. The engaged fighter avoids getting into a scissors and leads the fight back towards the free fighter.*



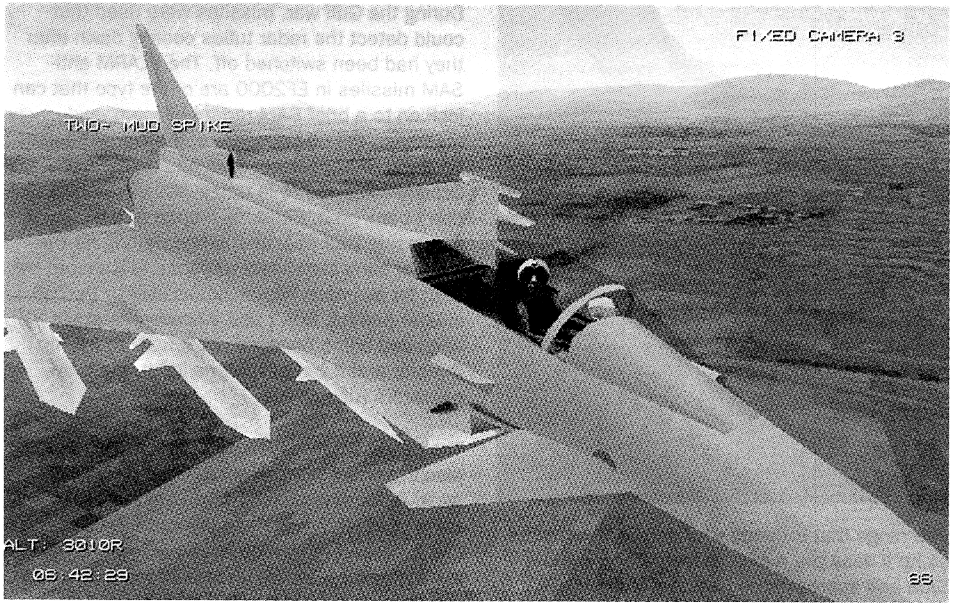
## WEAPON TACTICS



EF2000 is an effective ground attack aircraft

From the start, we designed EF2000 to be the best simulation of ground attack missions ever seen on a PC. To achieve this goal meant firstly developing highly contoured landscapes with detailed texture maps, so that flying close to the ground over undulating terrain would be as close to the real thing as we could get within the constraints of current technology. Secondly, we included a new generation of weapons aiming systems and avionics, including a terrain following aid. And thirdly, we gave all the weapons their own individual flight models, helping to provide a unique level of realism. On top of this, you are able to fly at any time of day in a wide variety of weather conditions.

On ground attack mission, you'll also come across spectacular effects. The AA batteries in cities at night are particularly awesome, sending out bright glows and streams of deadly tracer. Of course, it's also a tough challenge too, with enemy aircraft and ground-fire to keep your mind occupied. Best of all, you are able to watch spectacular explosions and view your handiwork as you pass by the target on your way home...



Use the views to get a better picture of your situation

### TARGET ZONE INGRESS/EGRESS

If you are preparing for a mission, give plenty of attention to the intelligence data on your target. Study the satellite views and memorise key details. If you are making a high-level attack, for example, it's easy to mistake buildings and details from 20,000 ft. And if you are attacking a site such as an airfield, you need to know which way the runway lies, so you can line up properly for an anti-runway attack.

Also try and plan your escape route on the MMD. If there are hills nearby, you can use these to cover your escape. Watch out for SAM sites!

### APPROACHING ENEMY GROUND UNITS EQUIPPED WITH SAMS

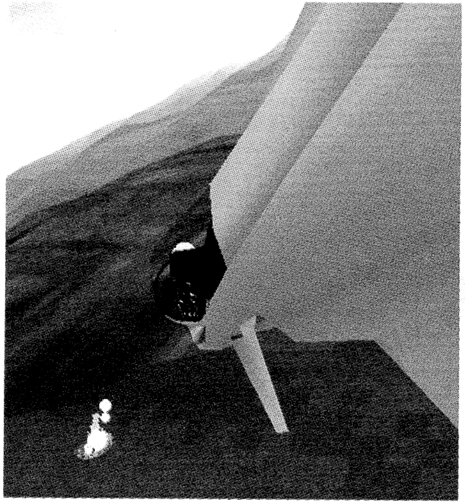
Be careful when making a low level approach on enemy troops. Invariably there are one or more SAMs down there, and these will take you by surprise. As you prepare your bombing run, have ALARM missiles active until the last possible moment. Switch back to ALARMs the moment your weapons have gone. Do not use afterburner at low-level, as this attracts IR SAMs like a magnet!

## WEAPON TACTICS

### DESTROYING SAM SITES

Compared to a modern jet aircraft, SAM equipment is cheap. And deadly. It provides lethal protection for all manner of sites and mobile units, and comes in all shapes and sizes: from small, shoulder mounted IR rockets to big long-range, high altitude missiles with massive proximity warheads that can bring down large bombers or several aircraft in a closely grouped formation.

After bitter experiences with SAM in modern theatres of war, the Israelis and Americans were quick to develop anti-SAM missiles. These lock onto the radar emissions of the SAM site, and zoom to the target at high speed to eliminate it. F-4 Phantom aircraft were adapted to the role of eliminating SAM threats, and became know as 'Wild Weasels'. Their dangerous air-defence suppression missions became know as 'Iron Hand'. Watch the film 'Flight of the Intruder' to get a idea of what SAM suppression is all about.



However, SAM operators have wised up to these tactics and weapons. Now a radar set is only switched on when the SAM operator thinks he has a fair chance of making a kill. That's usually at a range that exceeds your anti-SAM weapons, so he'll deny you a missile lock. If you avoid the SAM and approach the launch site directly, chances are the radar won't be switched on. However, fly past and the moment you show your six, the radar is on and you'll have a SAM screaming up your jet-pipe with no time to avoid it.

During the Gulf war, missiles were used that could detect the radar tubes cooling down after they had been switched off. The ALARM anti-SAM missiles in EF2000 are of the type that can lock on to a brief SAM radar emission, and memorise the co-ordinates of the signal source. So if the SAM operator switches on for just a second while you're in range, you've got him. But don't bank on it. Either fly around at a distance just inside your missiles' range waiting for the lock, or carry secondary weapons to wipe out the site; for example, Maverick missiles or BL-755 cluster bombs. Don't use a conventional MK 82 unguided bomb because you'll have to overfly the site and if you haven't nailed it, the SAM operators will nail you.

The height at which you approach a SAM site is also important. Fly below 500 ft and you will avoid radar detection until you are relatively close. Even if the site launches, the SAM may find it difficult to lock on to you at low level. For extra measure, switch on stealth mode and use your map to navigate to the site. If there are mountains or hills nearby, use these to mask you approach as much as possible. Radar cannot see through solid earth!

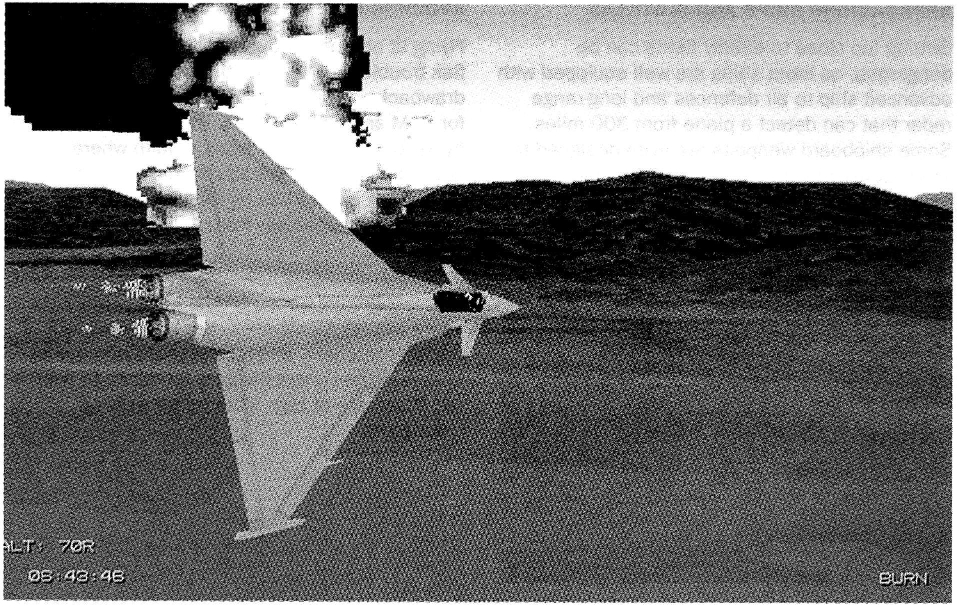
# GROUND ATTACK

## WEAPON TACTICS

### USING STEALTH

In simple terms, a plane not emitting any electronic signals is being 'stealthy'. But that doesn't make it a stealth fighter. A true stealth plane is designed to reflect radar waves in any direction except back to the receiver. It even absorbs some of them by using Radar Absorbing Materials (RAMS).

The EF2000 has stealth features; for example, the engine compressor turbines, which are a major radar reflector, are hidden from view by an 'S' shaped air intake. In addition, the use of composites and radar absorbent materials reduces the aircraft's Radar Cross Section (RCS) to about one fifth the RCS of an FA-18 Hornet. Even with a full weapons load, EF2000 has an unusually small RCS, which can help make it practically invisible at low level.



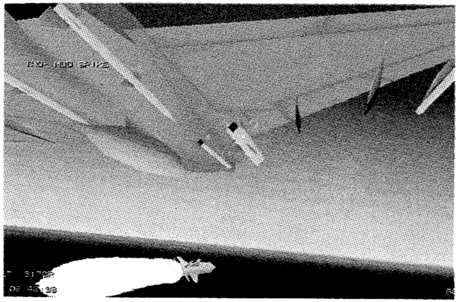
If you are on a bombing mission, always use JTIDS to monitor enemy ground and air movements in preference to radar. Use JTIDS with the map overlay to compare targets with the terrain. Try and ascertain the heading of enemy aircraft before switching on your radar in panic. Then plot an evasive course. Stay stealthy by keeping radar and ECM off. If possible, use mountains to mask yourself. If the threat light comes on, you have been spotted, so prepare to take combat countermeasures. If JTIDS is unavailable, simply keep an eye on your DASS to see whether any enemy aircraft or ground defences are tracking you. Switch on your radar only as a last resort, when defence becomes vital for survival.

# GROUND ATTACK

## WEAPON TACTICS

### APPROACHING SHIPS AND FLOTILLAS

Getting too close to enemy fleets can be dangerous, as most ships are well equipped with advanced ship to air defences and long-range radar that can detect a plane from 300 miles. Some shipboard weapons are even designed to shoot down cruise missiles, which caused so much damage to the British fleet during the Falklands War. What's worse, you'll have no terrain to hide behind.



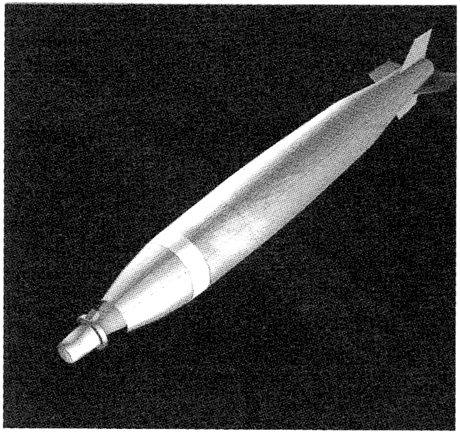
### AVOIDING FLAK AND SAMS

Flying at around 10,000 ft will keep you out of flak trouble, but higher altitude has its drawbacks. It makes you easier to detect, both for SAM and other aircraft. The alternative is to fly as low as possible, using stealth where possible. This will hide you from detection for longer, but makes you highly susceptible to ground fire - especially from shoulder launched SAMs.

To avoid ground based SAMs, treat them in the same way as AA missiles. Get ready to break at the right moment, and let the DASS dump chaff or flares when a missile gets too close to your tail. If you are at high altitude, try a diving manoeuvre.

## USING AG WEAPONS

### IRON BOMBS



*TYPICAL TARGETS*

Hardened aircraft shelters, Runways, Underground bunkers.

*DELIVERY TECHNIQUES*

Just because there are plenty of high tech weapons available in EF2000, don't ignore the plain-old iron bomb. In the Gulf War, more iron bombs were dropped than any other, simply because they are cheaper and more plentiful. Learn to drop an iron bomb accurately, and you really deserve the title of bombardier.

1. Medium altitude, starting at 15,000 ft above the Man Portable Air Defenses (MANPAD). Wingmen should split to gain the separation needed to avoid the blast of the bombs from the man in front.

2. When you reach 7 nms from the target, fly at 15 degrees offset to the target.

3. When 3 nms from the target, tip in towards it and begin a dive. Fly the bomb fall line through the target, and release the weapon as soon as the CCIP marker passes through it.

4. Recover from the dive, preferably before 5000 ft, and climb to a safe altitude.

NOTE: The steeper the dive, the more accurate your bombing will be. DO NOT RELEASE THE BOMBS BELOW 2000 FT, OR YOUR PLANE WILL BE DAMAGED BY THE BLAST.

### USING HIGH DRAG BOMBS

*TYPICAL TARGETS*

POL (Petrol, Oil, Lubrication), Headquarters, Communication sites, Radar sites, Missile sites, Aircraft in the open, Dockyards, Industrial complexes, Railways, Combat vehicles, Troops.

*DELIVERY TECHNIQUES*

1. Fly towards the ingress waypoint at low-level to avoid radar, with a speed of 480 knots. Maintain accurate timing!

2. At 65 seconds from the target, a countdown clock will appear.

3. Try to acquire the target visually.

4. Smoothly fly the bomb fall line through the target.

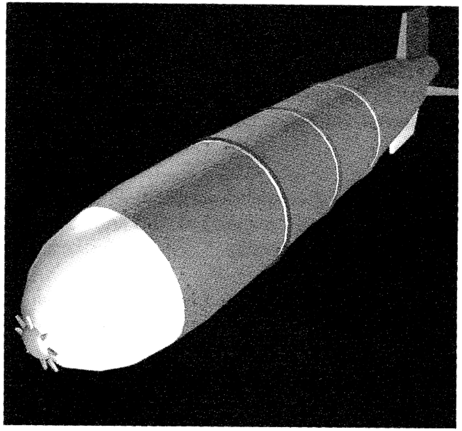
6. Release the weapon when the CCIP mark crosses the target.

7. Run out fast and low over the target. Do not turn for at least 30 seconds. Remember, you have stirred up a hornets' nest, and guns will be pointing at you!

# GROUND ATTACK

## USING AG WEAPONS

### USING THE BL-755 CLUSTER BOMB



*TYPICAL TARGETS*

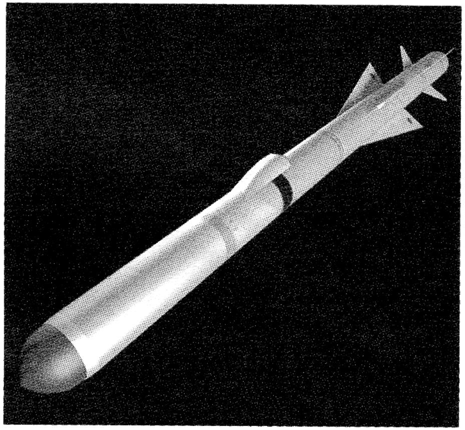
Tanks, Soft-skinned vehicles, Trains, Personnel, Artillery, Radar heads

*DELIVERY TECHNIQUES*

This weapon is designed for use against area targets. After release from the aircraft, the weapon dispenses large numbers of small bomblets that cover an area the size of a football pitch. The problems of self damage are much lower with cluster weapons, although the lower they are dropped, the smaller the area covered. The best height for deliver will be around 150 ft. Only 5 seconds spacing is required between aircraft delivering this weapon. Formations should attempt to achieve the minimum throughput time for aircraft over the target, in order to saturate the enemy defenses and overwhelm them.

Delivery procedures are the same as for the iron bombs, except that the wingmen do not need to split in order to gain separation.

### USING ALARM ANTI-RADIATION MISSILES



*TYPICAL TARGETS*

SAM sites and EWR, Naval SAMS and EWR

*DELIVERY TECHNIQUES*

There are two delivery techniques for ALARM in EF2000. The first is 'direct' mode, in which the missile will lock on to any radar emission within range and line of sight. All the pilot has to do is

## USING AG WEAPONS

make the decision to fire the missile, or hide from the radar by using terrain masking. The direct mode is best reserved for attack runs at low level, where the aircraft may be surprised by an active SAM battery. The missile will react quickly to the SAM radar, and should enable you to fire before the SAM has a chance to launch.

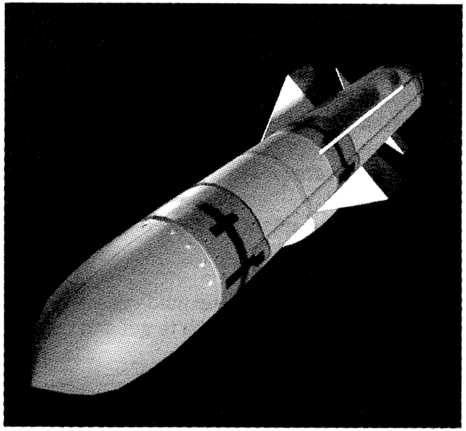
Use the indirect mode for clearing heavily defended territory. Fly in low, below 500 ft and when 15 miles from the target, release the ALARM in the general direction of the target. The missile will zoom climb to 40,000 ft and hang on a parachute until a radar emission is detected. When you are closer than 10 miles, turn on a parallel course to the target and 'pop-up' in order to encourage the enemy to switch on their radar, which in turn will cause a missile to fall on them.

1. Fly in fast and low.

2. Launch ALARM when fifteen miles from a suspected SAM site (indirect mode).

3. If the missile acquires a target automatically in the HUD, fire the weapon.

### USING SEA EAGLE MISSILES



*TYPICAL TARGETS*

Large surface vessels, oil rigs.

*DELIVERY TECHNIQUES*

The Sea Eagle is a stand-off weapon, which helps to keep the launch aircraft out of the lethal radius of naval SAM coverage. This is particularly important at sea, because terrain masking is simply not possible.

1. Fly to the ingress point at less than 500 ft to avoid detection.

2. At the ingress point the flight should split to attack the target from different directions. Pay attention to the required speed to achieve a correct Time On Target (TOT).

3. At 60 nm or less, pop-up to 2,000 ft and acquire your target using the Sea Eagle radar.

4. Cycle targets with the 'C' key. To get a closer look, use the Zoom key on the MFD.

5. When you have identified and acquired the right target, launch your weapon.

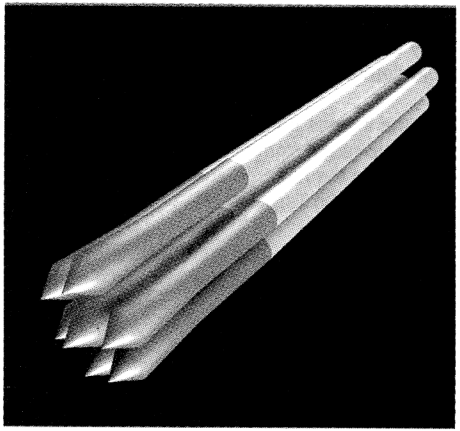
6. Drop to less than 500 ft and turn away from the target as quickly as possible.

7. Check your DASS to ensure that no SAMs are chasing you.

# GROUND ATTACK

## USING AG WEAPONS

### USING CRV-7 ROCKETS



*TYPICAL TARGETS*

Beach landing craft, coastal patrol boats, inflatable beach toys, tank convoys, trains, industrial sites.

*DELIVERY TECHNIQUES*

The CRV-7 rockets are designed to be used with a large stand-off from the target - typically 3 miles. The weapon is well-suited to the anti-shipping role against small craft that are not well defended, such as spy trawlers and landing craft. The weapon could be used against many other types of target, but becomes the second choice to the cluster bomb. The weapon is very fast (about Mach 4), and is reckoned by pilots to be 'the best fun you can have with your clothes on'. It goes wherever you point your aircraft.

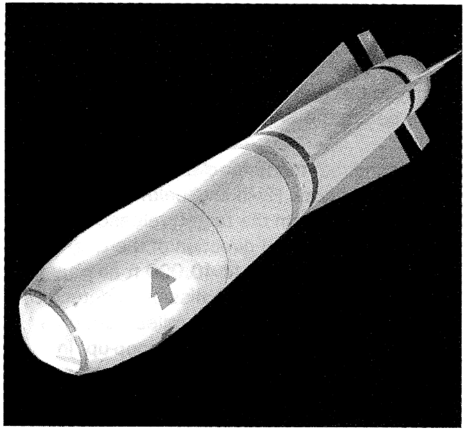
1. Fly towards an offset from the target of 4 nms at 480 kts, 500 ft.

2. At the offset point, pull-up hard - passing 5000 ft - then roll towards the target and begin a dive.

3. Aim with the pipper (death dot). Take a second or so to track the target then fire.

4. After the last rocket has gone, pull hard away from the target and egress at low level.

### USING THE MAVERICK IR GUIDED AG MISSILE



*TYPICAL TARGETS*

Armoured vehicles, parked aeroplanes, presidential limousines.

*DELIVERY TECHNIQUES*

The Maverick AGM-65D is designed for stand-off use at ranges of up to 12 miles.

# GROUND ATTACK

## USING AG WEAPONS

1. Fly towards the target at 480 kts.

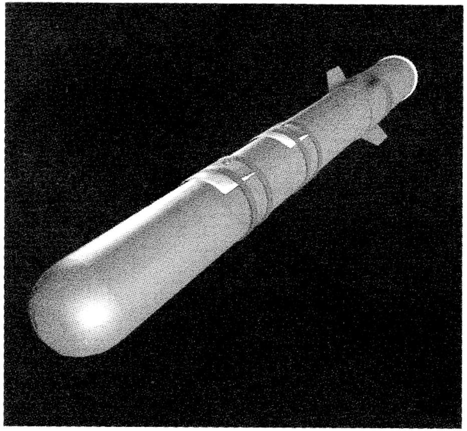
2. When about 12 nms from the target, offset to one side by about 15 degrees.

3. Select the left-hand MFD and slew the seeker head using the SHIFT Cursor keys.

4. The seeker will lock onto a target automatically. Check its identity in the IR screen under the HUD.

5. Vacate the area as quickly as possible.

### USING THE DURANDAL BOMBS



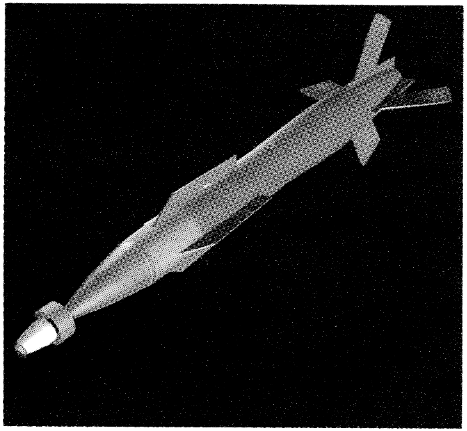
*TYPICAL TARGETS*

Runways.

*DELIVERY TECHNIQUES*

The Durandal is a retarded bomb designed specifically for runways. The delivery technique is identical to that of High Drag bombs.

### USING LASER GUIDED BOMBS



*TYPICAL TARGETS*

HAS, High Value Buildings, Command bunkers.

1. Fly towards the target and switch to TIALD (T key) when 15 miles away.

2. The TIALD pod should already be pointing at the waypoint.

## USING AG WEAPONS

3. If necessary, expand the Field-Of-View with the FOV MFD key.

4. Pick a point for tracking and press the TRK MFD key. Slew the track box with the SHIFT cursor keys until you are satisfied with the position.

5. Press the OFT key and slew the laser cross-hairs with the SHIFT cursor keys until you are satisfied with the positioning.

6. Press LAS of the MFD to begin lasing the target.

7. When the release marker is between the parameter markers, release the bomb.

8. Continue lasing the target until bomb impact.

### USING THE MAUSER 27mm CANNON

*TYPICAL TARGETS*

Soft-skinned vehicles, trains, personnel, artillery, radar heads.

*STRAFING TECHNIQUES*

Strafing is now far less popular than it used to be in days of old. This is mainly because of the dangers that the aircraft is exposed to while making an attack. In addition, strafing from a fast moving jet with any accuracy is very hard indeed. However, it is great fun in EF2000 so go ahead and strafe. The technique is simple. Approach the target in a shallow dive. The cannon pipper is calibrated to three miles, so wait until the range clock starts to count down. Start firing just before the target and 'walk' the cannon fire across it. You should not strafe too late or in too steep a dive, because considerable debris can be thrown into the air and this may damage your aircraft.

# GROUND ATTACK

## STRIKE MISSIONS

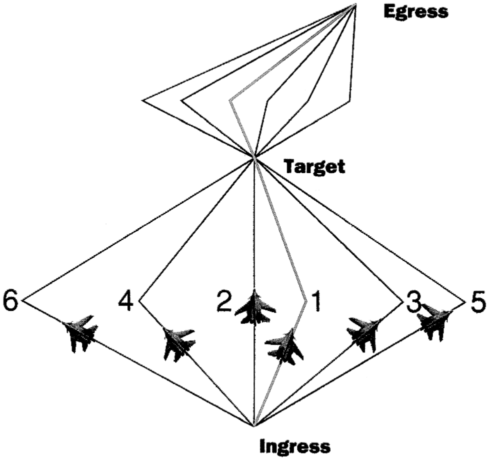
The strike mission will either be carried out at low level to avoid detection by the enemy or at high level to conserve fuel. Flying low gives you the best chance of avoiding detection by enemy AWACS and early warning sites.

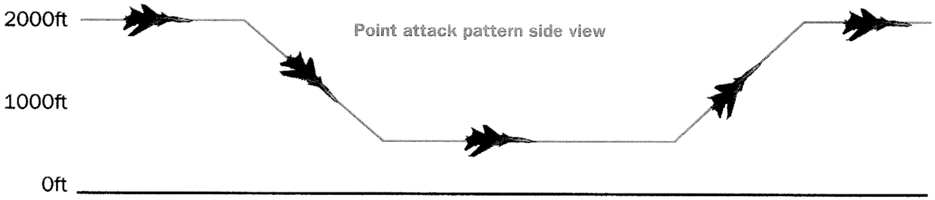
Follow your waypoint route to target, defending your airspace and responding to any threats you encounter. Remember the primary objective of the strike mission is to destroy the target, so you want to avoid air-to-air combat if possible as this will inevitably deplete your fuel reserves and could even lose you wingmen. If you are flying with escort then let the escort fighters deal with any threat while you turn away from the fight to ensure your safety before returning to the waypoint route. Your waypoint route may take you through neutral territory, so remember not to shoot anything down or target any ground installations unless you are threatened. Combat against neutral forces can have implications far beyond the immediate threat of air interception.

When you get to your ingress waypoint (or IP, Initial Point) you must begin your attack pattern route to target to allow accurate and safe deployment of your weapons. There are four main types of attack pattern which correspond to the weapons packages for the EF 2000. You must study these patterns before flight to ensure that your weapons are delivered correctly.

A 'point attack' pattern is used for free-fall bombs, cluster bombs, Durandals and rockets. The diagram below shows your route relative to your wingmen. Make note of the turning points and their relative distance from target as well the altitude at each point, in particular the release altitude for the weapon.

Point attack pattern plane view



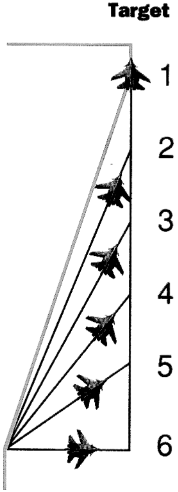


Point attack pattern side view

## STRIKE MISSIONS

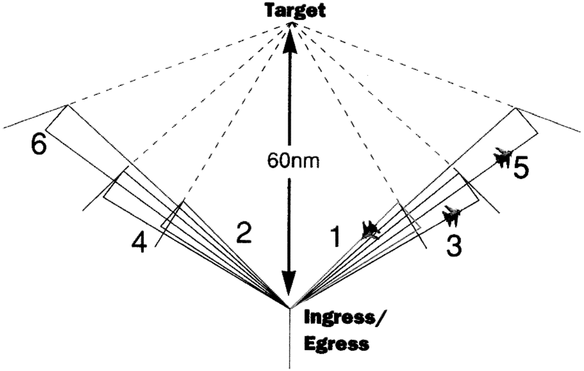
A 'stand-off' attack pattern is used for the deployment of laser guided bombs, and can also be used for Mavericks and rockets.

Stand-off attack pattern plane view



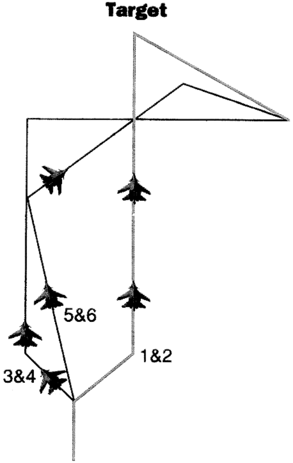
The Sea Eagle attack pattern is used only for the deployment of the Sea Eagle anti-ship missile. Make note of the turning points and their relative distance from target as well the altitude at each point, in particular the release altitude for the weapon.

Sea Eagle attack pattern plan view



The Alarm attack pattern is used only for the deployment of the Alarm anti-radiation missile.

ALARM attack pattern plan view



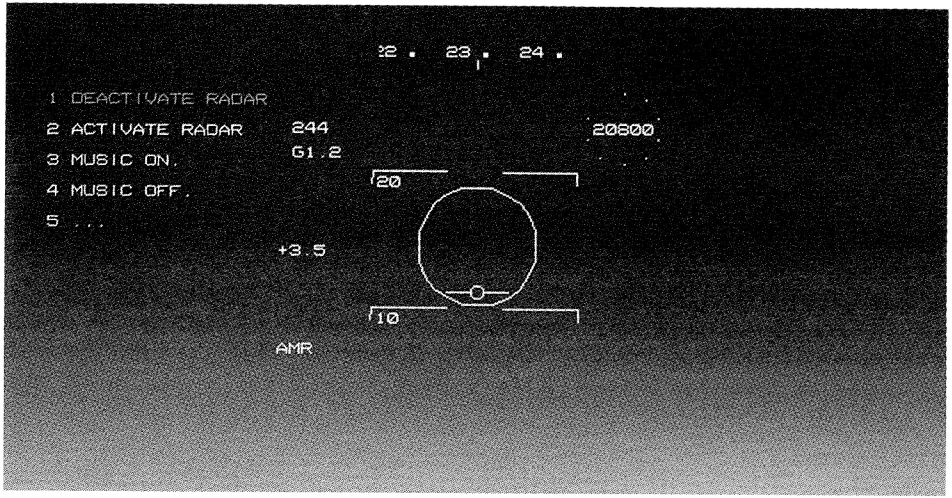
## STRIKE MISSIONS

When you have released you weapons it is time to regroup with your wingmen and head back to base. If you encountered any SAM threats on route to target and your route home takes you close to these areas, remember to make a diversion to avoid them. If you have the opportunity of destroying any additional enemy targets on the route back to base then do so, but be careful to only strike enemy and not neutral targets.

On return to base there is the possibility that your base will have been destroyed and you will be unable to land. In this case you will need to fly to your diversion airfield. In general this airfield will be less than 50 nm from your home base so your fuel should get you there. If the worst happens and your diversion field has also been destroyed, it is up to you to find the closest NATO base to make an emergency landing - good luck!

# EF2000 COMMUNICATIONS

## SENDING & RECEIVING MESSAGES



The Wingman control menu

In EF2000, you can communicate with other aeroplanes and with airbases by radio. Pressing TAB or a number key activates the communications menu system. A series of messages or commands will appear on screen, each preceded by a number. Simply press the number of the one you want on the main keyboard. Commands followed by '...' represent sub-menus. Messages will be spoken by your pilot, and acted on by whoever you are speaking with.

In the SmartPilots system, the messages you send are the same messages which the computer-controlled aircraft use to communicate with each other. Their pilots are unaware that your messages originate from a human pilot and not another computer-controlled aircraft. Similarly, you will be sent messages from the other pilots, and these will appear on screen for you to respond to.

### MAIN MENU

TACTICAL... Selects the TACTICAL MENU.

FORMATION... Selects the FORMATION MENU.

ENGAGE... Instructs your wingmen to engage enemy aircraft and selects engagement menu.

FLIGHT COMMS... Selects the FLIGHT COMMUNICATIONS MENU.

REPORT... Selects the REPORT MENU.

# EF2000 COMMUNICATIONS

## SENDING & RECEIVING MESSAGES

### TACTICAL MENU

ACTIVATE RADAR: Instructs all wingmen to turn on their radar. Most of the aeroplanes in EF2000 are equipped with a scanning radar, which takes into account radar cross-section, pulse-doppler effects and terrain masking. Your wingmen will report any radar sightings, but using radar will alert enemies to your presence.

DEACTIVATE RADAR: Instructs all wingmen to turn off their radar. They will still use IRST, and activate radar for close combat.

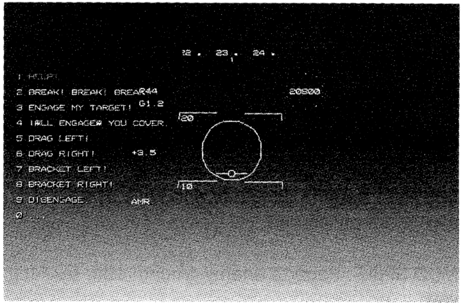
MUSIC ON: Instructs all wingmen to activate ECM. If flying as an Escort ECM group, use ECM to protect the strike group when it is attacked. Otherwise, use in combat, but only after being detected, as ECM, like radar, acts as a beacon to the enemy.

MUSIC OFF: Instructs all wingmen to deactivate ECM. Do so as soon as the danger is over.

### FORMATION MENU

ARROW GO: This is a close formation in the shape of an arrowhead. Use only in friendly territory to keep an eye on your wingmen.

BATTLE GO: This selects combat spread, or battle formation, which is ideal for CAPs and missions in enemy territory, due to mutual visual and positional coverage.



More Wingman menus

ECHELON GO: This selects echelon, a very close formation which can disguise the flights numbers from some enemy radars.

### ENGAGEMENT MENU

HELP: If you are in serious trouble, ask your wingmen to help you out. Usually, your own partner will respond, unless incapacitated.

BREAK, BREAK, BREAK: Instructs your wingman to break turn in response to an enemy aircraft or missile.

I'LL ENGAGE, YOU COVER: Instructs your wingman to act as free fighter in the double attack system. You should then engage.

ENGAGE MY TARGET: Instructs your wingman to engage your current target.

BRACKET LEFT/BRACKET RIGHT: Instructs your wingman to take the left or right arm of a bracket manoeuvre.

DRAG LEFT/DRAG RIGHT: Instructs your wingman to attempt a drag manoeuvre.

DISENGAGE: Instructs the whole group to cease fighting.

## SENDING & RECEIVING MESSAGES

### FLIGHT COMMS MENU

To talk to other flights, or the control tower, this is the menu that you require.

TO JOIN: To obtain extra fuel for yourself and your wingmen, a radio request for the nearest tanker. Use whenever fuel looks like being a problem, and always on reaching a refuel waypoint.

FOR RECOVERY: This issues a request to air traffic control for clearance to land for your entire flight. If no runways are clear, you will need to enter a holding pattern.

REQUEST EMERGENCY LANDING: When your aeroplane is damaged and you simply want to put it on the deck, send this message. It will override all regular ATC and allow you to touch down almost immediately.

MAYDAY! WE ARE UNDER ATTACK!: If you are under attack by enemy fighters, this requests backup from AWACS or your designated cover flight. If you have a cover flight, let them do the work; don't waste time and fuel in air-to-air combat.

### REPORT MENU

It is your responsibility to inform the flight of any new information or hazards. This is especially important if you are a wingman, as you must report anything of interest to your wing leader.

SPIKE: Reports enemy radar detected on your DASS.

BANDIT: Reports an enemy attacking your flight.

MISSILE: Reports launch of a missile by a SAM site or enemy aircraft.

MUD SPIKE: Reports enemy ground radar tracking you.

CONTACT: Reports radar or IRST sighting of hostiles.

### RECEIVING MESSAGES

On many occasions, other aircraft or airbases will need to send messages to you. You will hear these if you have an appropriate sound card or enough RAM, and they will also appear at the top of the screen. Up to 10 messages will be stored, and appear in turn when you acknowledge the previous message. Messages are acknowledged by pressing the 'Y' or 'N' keys. Some messages take the form of requests or questions. In this case, press 'Y' to comply with the request, or 'N' to refuse. For example, AWACS might send a message like:

'INCURSION BY HOSTILES AT 5 DEGREES, 90 NM, ANGELS 10. CAN YOU INTERCEPT?'

If you are low on fuel, this might not be possible. Just press 'N', and your pilot will reply:

'NEGATIVE!'

The AWACS aeroplane will find another CAP to perform the intercept (and get the glory)!

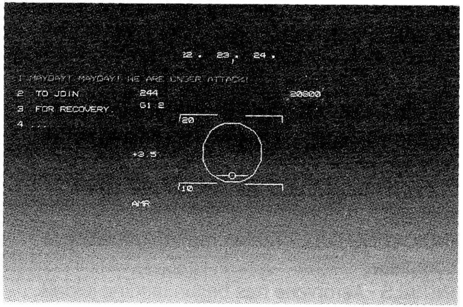
# EF2000 COMMUNICATIONS

## MESSAGE SUMMARY

ACTIVATE RADAR - Instruction from wingleader to turn radar on.
AIRBORNE - Indicates that a pilot has taken off.
ARROW GO - Instruction from wingleader to change to arrow formation.
ACTIVATE RADAR - Instruction from wingleader to turn radar on.

BANDIT - Warning of enemy aircraft.
BATTLE GO - Instruction from wingleader to change to battle formation.
BINGO - Pilot has only enough fuel to reach base.
BRACKET LEFT COPY! - Acknowledgement from wingman of bracket left instruction.
BRACKET LEFT! - Instruction to form the left arm of a bracket manoeuvre.
BREAK LEFT - Command to execute a hard turn left.
BREAK! BREAK! BREAK! - Command to leave the refueler in a hurry.
BUDDY SPIKE - Message indicating that the pilot has detected friendly radar on his DASS.

CHECK - Affirmative confirmation of an action or message.
COPY - Affirmative confirmation of an action or message.



The flight comms menu

COPY,ON MY WAY - A response to a request for help.
CLEARED TAXI COUGAR - ATC message that your flight should prepare to taxi.
CLEARED TO BREAK - Instruction that you may detach from the tanker.
CLEARED TO JOIN LEFT SIDE - Instruction to formate behind the tanker.
CLEARED DEPARTURE - Message from ATC that the aircraft is cleared to depart.
CONTACT LEFT HOSE - Confirmation of a good connection with the refueler.
CONTACT 340, 22, ANGELS 10 - Sighting on heading 340, range 22 nm, altitude 10,000 ft
CONTINUE, HE'S FOLLOWING - Report that a drag manoeuvre is working.
CLEARED TAKE-OFF, WIND 360, 10 KNOTS - ATC grants permission to take-off; wind is blowing on 360 degrees at 10 knots.
CLEARED TAXI RUNWAY 22 - Indicates where a pilot should taxi to.

DEACTIVATE RADAR - Instruction from wingleader to turn radar off.
DISENGAGING - Message indicating that the fighter is disengaging from air-to-air combat.
DRAG RIGHT COPY! - Acknowledgement from wingman of drag right instruction.
DRAG RIGHT! - Instruction to attempt a drag manoeuvre to the right.

ECHELON GO - Instruction from wingleader to change to echelon formation.
ENGAGE! - Instruction from wingleader to engage air targets.
ENGAGE MY TARGET! - Instruction to engage the sender's target.
ENGAGING! - Report that the fighter is engaging.
ENGINE FIRE - Report that one or both of the aeroplane's engines is on fire.

## MESSAGE SUMMARY

FINALS, GEAR DOWN - Aeroplane is on final approach.
FOR RECOVERY - Flight is ready to begin landing initials.
FOX ONE! - Report of launch of radar guided missile.
FOX TWO! - Report of launch of short range IR missile.
FUEL FLOWS - Tanker indicates that refuelling is in progress.
FUEL LEAK - The aeroplane has a fuel leak due to damage.

GEAR DAMAGE - Problem with undercarriage.
GUNS GUNS GUNS! - The aircraft is firing cannon.

HELP! - Message from a plane requesting urgent assistance.
HOSTILES HEADING FOR BOTTLE GROUP - Report from AWACS that enemy fighters are approaching Bottle group.
HOSTILES - Report from AWACS of enemy fighters nearby.
HYDRAULIC FAILURE - The aeroplane hydraulics have failed due to damage.

INCURSION BY HOSTILES AT... CAN YOU INTERCEPT? - Report from AWACS of enemy incursion into allied territory, followed by request for CAP to intercept.

I'LL ENGAGE, YOU COVER - Instruction that the fighter will engage; the wingman should act as free fighter.
I'M HIT! - Report that the aircraft has taken damage.
INDICATING FULL - Tanker reports refuelling is complete.
INITIALS - Aeroplane has begun landing initials.
I.P. - Pilot has reached ingress point on mission.

KNOCK IT OFF - Instruction to disengage from combat.

LOSING CABIN PRESSURE - The aeroplane is losing pressure due to damage.
LOSING OIL PRESSURE - The engine lubrication system has failed due to damage.

MAYDAY MAYDAY! EJECTING! - Message from any plane that the pilot is ejecting.
MAYDAY! MAYDAY! WE ARE UNDER ATTACK! - Message from another group that they are under attack from enemy aircraft.
MISSILE! - Warning of incoming missile.
MOVE ASTERN RIGHT HOSE - Command from the refueler to join to the right hose.
MUD SPIKE - Warning of SAM radar threat.
MUSIC! - The pilot is being jammed.
MUSIC ON! - Instruction from wing leader to turn ECM on.
MUSIC OFF! - Instruction from wing leader to turn ECM off.

NEGATIVE! - Negative response to a wingman or AWACs request.
NEGATIVE, HOLD-OFF, AIRFIELD BUSY - Message to enter a holding pattern at a busy airfield.

ON THE BRAKE - Aeroplane is slowing down for finals.
OXYGEN FAILURE - Report of damaged oxygen system.

PAN, PAN, PAN! REQUEST IMMEDIATE LANDING! Request for emergency landing clearance.
POSSIBLE FIGHTERS LAUNCHING FROM TRONDHEIM - Report from AWACS of enemy aircraft taking off from Trondheim airbase.

READY FOR DEPARTURE - Wing leader indicates readiness for take-off.
REHEAT FIRE - The afterburners are on fire.

# EF2000 COMMUNICATIONS

## MESSAGE SUMMARY

REQUEST PERMISSION TO ENGAGE - Message from wingman requesting clearance to engage in air combat.
REVERSE - Report that a drag manoeuvre has failed.
ROGER! - Acknowledgement from AWACS, tanker, JSTARS or ATC.
RUNNING IN - The pilot has commenced a ground attack run.
RUNWAY VACATED - Flight has cleared the runway.

SCRAMBLE! SCRAMBLE! - Take-off immediately!
SPIKE - Message indicating that the pilot has detected enemy radar on DASS.
SPLASH TWO - Report of second air-to-air kill.
SPLASH EIGHT COMPLETE - All bandits destroyed after eighth kill.
STRUCTURAL DAMAGE - Problem with the airframe.
STUD ONE GO - Change to ATC frequency.
STUD TWO GO - Change to departure frequency.
STUD THREE GO - Change to tactical frequency.
STUD... Indicates a change of radio frequency.

TALLY-HO - Enemy in sight.
TARGET TANKS BEARING 240, RANGE 10. CAN YOU ATTACK?- JSTARS or FAC request to destroy enemy vehicles at a given bearing and range.
TO JOIN - Request for air-to-air refuelling.

TOWER, COUGAR TAXI - ATC tells Cougar flight to prepare to taxi.
TURNING TO BANDIT - Message from wingman in bracket manoeuvre indicating a turn towards the bandits in the final phase.

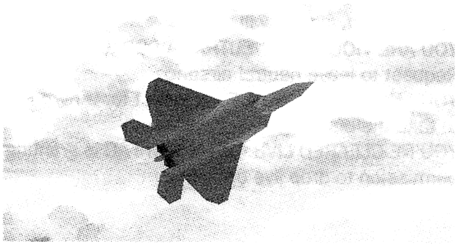
UPDATE YOUR TARGET - Report from AWACS, JSTARS or FAC providing new target intercept data.
USING RUNWAY 22 - Message from tower granting landing clearance and giving runway number.

VECTOR TO INTERCEPT - Instruction from wingleader to wingmen of intercept.

WEAPONS GONE - Notification that AG weapons have been released.

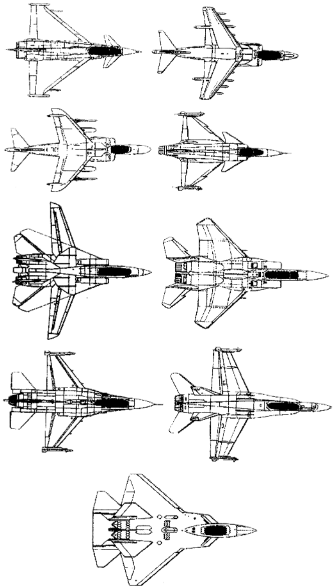
YOU ARE CLEARED TO ENGAGE - Instruction from AWACS to engage at will.
YOU ARE VIOLATING NEUTRAL AIRSPACE... - Request to leave neutral airspace.
YOU ENGAGE, I'LL COVER - Request for wingman to take the offensive.
YOU'RE CLEARED LIVE - JSTARS or FAC is granting permission to drop live ordnance.

## NATO FIGHTERS



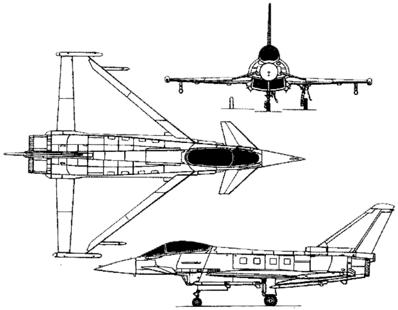
In contrast to the Soviet approach, development of NATO fighter aircraft has largely tended towards complexity and high quality, rather than simplicity and ease of manufacture. The reason for this has been mainly due to the West's superior technology, and a paranoia of losing its leading-edge position during the 'Cold War'. Perhaps the greatest example of 'Cold War' reactionary design philosophy was the enormously expensive F-15, which was developed to counter the supposedly unparalleled performance of the MiG-25 Foxbat. The myth was shattered when a Russian pilot defected to Japan in his Foxbat, where it was quickly shown to be less capable than previously thought. The F-22 Advanced Tactical Fighter is also a very expensive aircraft, although the F-16 and Saab Gripen are rare examples of high-quality, low-cost fighters incorporating the best of modern technology.

It's hardly surprising that inexpensive yet potent Russian aircraft have found a ready market in many of the world's less wealthy countries, while Western aircraft have proved less adaptable to the needs of other nations. Even today, the task of maintaining a diversely equipped NATO airforce is a major logistics challenge compared with the upkeep of standardised Russian aircraft designs with their low-cost spares. However, this situation has changed in recent years, as new generation of NATO aircraft have been developed by consortium, in order to spread the enormous costs of modern combat aircraft development. Tornado and the EuroFighter are good examples. Furthermore, collaboration between Europe and the United States has increased, as a stealthy replacement is being sought for the Panavia Tornado and other reconnaissance and attack aircraft.



Anti-clockwise from top-left: EuroFighter, Harrier GR7, F-14, F-16, F-22, FA-18, F-15, JAS39, Sea Harrier

## EUROFIGHTER EF2000



The EF2000 is the product of a four nation consortium made up of the UK, Germany, Italy and Spain. As with many modern aircraft, development has been marred by political wrangling leading to major design compromises. The technology was tested extensively by British Aerospace in the form of the EAP (Experimental Aircraft Programme), which the EF2000 closely resembles. This demonstrator was to save millions of pounds of development costs, and reduce the EF2000 development time by several years.

The EF2000 is a canard equipped delta aircraft optimised for the air superiority role but able to be used for ground attack. Extensive use of high technology materials has been made including carbon composites, glass reinforced plastics, titanium, and aluminium lithium, in 80% of the airframe. The cockpit environment is one of the most advanced in the world using digital fly-by-wire and multi function displays. The pilot wears a helmet with built in sight and night-vision enhancements. Like the Gripen and Rafale the EF2000 uses canards and a broad delta wing to get the best combination of agility, lift and speed.

### ARMAMENT

One 27mm Mauser cannon, with thirteen hardpoints (three wet) for: the S-225 long-range, AIM 120 AMRAAM medium range, ASRAAM and AIM 9S short range air-to-air missiles, a wide range of air-to-surface missiles including the AGM65 Maverick, the ALARM anti radar missile, the Sea Eagle anti-ship missile, Paveway laser guided bombs, CR-V7 unguided rockets, BL755 cluster bombs, free fall, and retarded bombs.
Maximum external fuel or weapons payload is 6500 kg (14330 lb).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

| | |
|---|---|
| Wingspan | 10.5m (34 ft 5.5 in) |
| Length | 19.5m (47 ft 7 in) |
| Height | 6.4m (21 ft) |

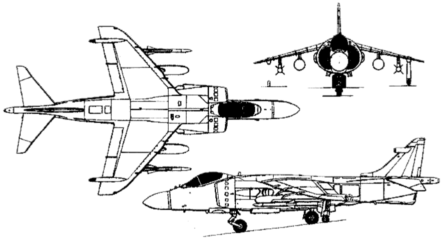
| | **EF2000** |
|---|---|
| Max level speed at height | Mach 2<br>1472 knots<br>2060 kmh<br>1280 mph |
| Max level speed at sea-level | NA |
| Service ceiling | 18290m<br>60000 ft |
| Required runway length | 500m<br>1640 ft |
| Max Range: with max internal fuel | 600 n miles<br>1112 km<br>690 miles |
| Max Range: with drop tanks | NA |

Equipment for inflight refuelling is fitted.

Performance Table

# NATO FIGHTERS

## SEA HARRIER FRS-2



The Sea Harrier was a development of the highly successful Harrier vertical and short take off attack aircraft, featuring a high mounted cockpit with vastly improved all-round visibility. It is designed for use from Royal Navy warships, principally the Invincible Class aircraft carriers equipped with 'Ski Jump' take-off ramps, which allow fully laden aircraft to launch without catapult assistance. The new design features an extended nose, which houses the Blue Vixen radar, forerunner to the powerful ECR-90 type used in EuroFighter. This adds powerful medium range air-to-air capabilities, as well as an anti-ship ability, to this accomplished small aircraft. The amazing agility of the Harrier was proven in the Falklands war. The vectored thrust nozzles can be used in flight to tighten turns, or to suddenly stop the aircraft in mid manoeuvre.

### ARMAMENT

One hardpoint mounted 30mm gun pod, with seven hardpoints for: the AIM 120 AMRAAM medium range, the AIM 9 Sidewinder Short-Range air-to-air missiles, a range of air-to-surface missiles, laser guided bombs, unguided rockets, cluster bombs, free fall, and retarded bombs.
Maximum external fuel or weapons payload is
STOL (short takeoff and landing) 3630 kg (8000 lb)
VTOL (vertical takeoff and landing) 2270 kg (5000 lb)

---

### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

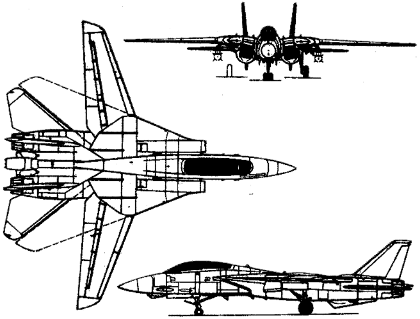
| | |
|---|---|
| Wingspan | 7.7m (25 ft 3 in) |
| Length | 14.17m (47 ft 7 in) |
| Height | 3.71m (12 ft 2 in) |

| | **FRS-2** |
|---|---|
| Max level speed at height | Mach 1.25<br>846 knots<br>1185 kmh<br>736 mph |
| Max level speed at sea-level | Mach 1.11<br>635 knots<br>1176 kmh<br>730 mph |
| Required runway length | 1000 ft<br>or 450 ft with ski jump |
| Maxiumum range with internal fuel | 1800 n miles<br>3333 km<br>2071 miles |
| Maxiumum range with drop tanks | 1850 n miles<br>3428 km<br>2130 miles |

Equipment for inflight refuelling is fitted.

Performance Table

## GRUMMAN F-14 TOMCAT



The F-14 was born out of the failed Navy F-111B project. It was the first aircraft to use the swing wing design at sea. Even after twenty years of service the F-14 remains an extremely powerful fighter. The Hughes AWG9 radar is capable of tracking twenty four targets simultaneously and engaging six targets at once, with the long-range (up to 150 miles) AIM 54 Phoenix air-to-air missile.

The designers adopted the swing wing design to meet the many conflicting requirements of aircraft carrier operations. For the first ten years of service the engines proved unreliable. This was solved by replacing the original engines with a later design.

The F-14 is the only Navy aircraft capable of carrying the TARPS (Tactical Air Reconnaisance Pod System).

### ARMAMENT

One 20mm 6 barrel rotary gun, AIM 54 Phoenix long-range missile, AIM 120 AMRAAM medium range missile, and AIM 9 Sidewinder short-range air-to-air missile. The F14 D can also carry the full range of freefall, retarded, and precision guided air to ground munitions.
Maximum external fuel or weapons payload is 6,577 kg (14,500 lb).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

| | |
|---|---|
| Wingspan (spread) | 19.54m (64 ft 1.5 in) |
| Wingspan (swept) | 11.65m (38 ft 2.5 in) |
| Length | 19.1m (62 ft 8 in) |
| Height | 4.88m (16ft) |

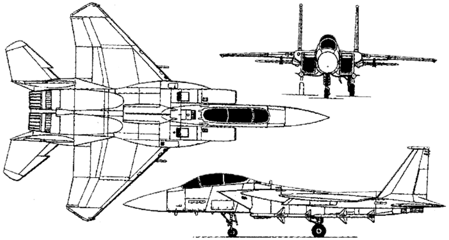
| | **F-14** |
|---|---|
| Max level speed at height | Mach 2.34<br>1,340 knots<br>2,480 km/h<br>1,540 mph |
| Max level speed at sea-level | Mach 1.2<br>795 knots<br>1,470 km/h<br>915 mph |
| Service ceiling | 16,765 m<br>55,000 ft |
| Required runway length | 396 m<br>1,300 ft |
| Max Range: with max internal fuel | N/A |
| Max Range: with drop tanks | 1,730 nm<br>3,204 km<br>1,991 miles |

Equipment for inflight refuelling is fitted.

Performance Table

# NATO FIGHTERS

## MC DONNELL DOUGLAS F-15 EAGLE



The F-15 was first designed to excel in the air superiority role as a manouverable dogfight aircraft. It was later adapted to become an extremely capable attack fighter, especially in the twin seat F-15E version. Prototype F15s set a number of time to height records including a time of 207 seconds to an altitude of 18,290 m (60,000 ft).

The largely glass instrument cockpit pointed the way forward in the design of all future flight controls and cockpit instrumentation.

The F-15 was a 'panic' reaction to rumours concerning the capabilities of the MiG-25. After billions of dollars in development costs, the defection of a Russian pilot complete with 'Foxbat' aircraft revealed that the fears were unjustified. The F-15 also embodies many of the lessons learned in Vietnam concerning the need for agility.

### ARMAMENT

One 20mm 6 barrel rotary gun, AIM 120 AMRAAM medium range, AIM 9 Sidewinder short-range air-to-air missiles, AGM65 Maverick, GBU15 optically guided bombs, Paveway laser guided bombs, unguided rockets, Rockeye cluster bombs, free fall and retarded bombs from 113 kg (250 lb) to 907 kg (2000 lb). Maximum external fuel or weapons payload is 7257 kg (16000 lb).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

| | |
|---|---|
| Wingspan | 13.05m (42 ft 9.75 in) |
| Length | 19.43m (63 ft 9 in) |
| Height | 5.63m (18ft 5.5 in) |

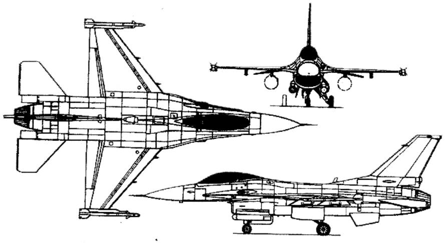
| | **F-15** |
|---|---|
| Max level speed at height | Mach 2.5<br>1,430 knots<br>2,650 km/h<br>1,650 mph |
| Max level speed at sea-level | Mach 1.22<br>800 - knots<br>1,480 km/h<br>920 mph |
| Service ceiling | 18,290 m<br>60,000 ft |
| Required runway length | 275 m<br>900 ft |
| Max Range: with max internal fuel | 1,042 n miles<br>1,930 km<br>1,200 miles |
| Max Range: with drop tanks | 2,500 nm<br>4,633 km<br>2,879 miles |

Equipment for inflight refuelling is fitted.

Performance Table

# NATO FIGHTERS

## LOCKHEED F-16 FIGHTING FALCON



The United States Airforce chose the F-16 as the winner of the 1972 lightweight fighter competition between the Lockheed YF-16, and the Northrop YF-17. Since entering service with the US Air Force the F-16 has been bought by 17 airforces around the world.

Though originally intended to be a simple and affordable fighter using the latest fly-by-wire flight system, and side mounted control stick, the F-16 was developed into a highly effective dogfight, and ground attack aircraft. The F-16 is still used as *the* yardstick by which other fighters measure their close combat manouverability. The under fuselage air intake set a design trend continued in the EF 2000.

### ARMAMENT

One 20mm 6 barrel rotary gun. The F-16 has nine hardpoints for: The AIM 120 AMRAAM medium range, the AIM 9 Sidewinder short-range air-to-air missiles, the AGM65 Maverick air-to-surface missile, the AGM88 HARM anti radar missile, Paveway laser guided bombs, unguided rockets, Rockeye cluster bombs, free fall, and retarded bombs.
Maximum external fuel or weapons payload is 6895 kg (15200 lb).

### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

| | |
|---|---|
| Wingspan | 9.45m (31 ft) |
| Length | 15.03m (49 ft 4 in) |
| Height | 5.09m (16ft 8.5 in) |

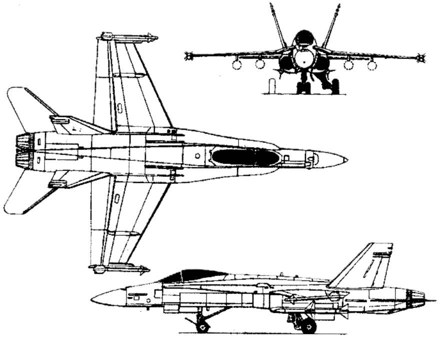
| | **F-16** |
|---|---|
| Max level speed at height | Mach 1.6<br>1,140 knots<br>2,125 km/h<br>1,320 mph |
| Max level speed at sea-level | Mach 1.2<br>795 knots<br>1,470 km/h<br>915 mph |
| Service ceiling | 15,240 m<br>50,000 ft |
| Required runway length | 533 m<br>1,750 ft |
| Max Range: with max internal fuel | 1,129 nm<br>2,100 km<br>1,300 miles |
| Max Range: with drop tanks | 2,100 nm<br>3,890 km<br>2,420 miles |

Equipment for inflight refuelling is fitted.

Performance Table

# NATO FIGHTERS

## MC DONNELL DOUGLAS FA-18 HORNET



The FA-18 arose out of the US Navy concern about the escalating costs of the F-14, and the need to replace the A6 Intruder. This aircraft was chosen as a development of the losing YF-17 design in the 1972 lightweight fighter competition as the YF-17 was a far more expandable, and suitable design for over water operation. The FA-18 has been developed into a truly all capable fighter, incorporating the by-now standard fly by wire controls and very advanced digital cockpit instruments.

The aerodynamic design allows this aircraft to fly at high angles of attack while manouvering fully loaded. The FA-18 is able to carry a huge range of weapons including nuclear stand off missiles, and is able to attack a ground target, or fly an interception mission with equal capability, and fly its own fighter sweep on the way home!

The FA-18 still has a huge development potential which is being pursued in the form of the bigger FA-18E, the lightweight export F-18L Cobra, and the canard equipped FA-18G.

### ARMAMENT

One 20mm 6 barrel rotary gun. The FA-18 has nine hardpoints for: The AIM 120 AMRAAM medium range, the AIM 9 Sidewinder short-range air-to-air missiles, the AGM62 Walleye, and AGM65 Maverick air-to-surface missiles, the AGM88 HARM anti radar missile,the AGM84 Harpoon anti ship missile, Paveway laser guided bombs, unguided rockets, Rockeye cluster bombs, free fall, and retarded bombs, plus a nuclear stand off capability.
Maximum external fuel or weapons payload is 7031 kg (15500 lb).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

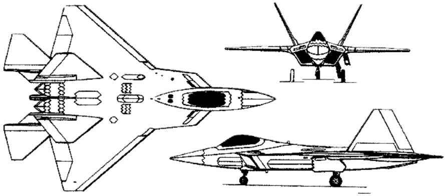
| | |
|---|---|
| Wingspan | 11.43m (37 ft 6 in) |
| Length | 17.07m (56 ft) |
| Height | 4.66m (15ft) |

| | **FA-18** |
|---|---|
| Max level speed at height | Mach 1.8<br>1,034 knots<br>1,915 km/h<br>1,190 mph |
| Max level speed at sea-level | Mach 1.2<br>795 knots<br>1,470 km/h<br>915 mph |
| Service ceiling | 18,290 m<br>60,000 ft |
| Required runway length | 426 m<br>1,400 ft |
| Max Range: with max internal fuel | 1,800 nm<br>3,333 km<br>2,071 miles |
| Max Range: with drop tanks | 1,998 nm<br>3,700 km<br>2,300 miles |

Equipment for inflight refuelling is fitted.

Performance Table

## LOCKHEED F-22A



The F-22A is the result of a collaboration between Lockheed, General Dynamics, and Boeing to design and build a stealthy combined air-superiority, and ground attack fighter. The F-22A was the winner of the 1990 Fly-Off Competition narrowly beating the Northrop-McDonnell Douglas YF-23.

The F-22A makes extensive use of ultra-modern materials and 3D computer modelling for its blended surfaces. The aerodynamics have been optimised for a stealthy, agile shape compromise. Reliability and front line maintainability were much improved over previous fighter designs. All weapons are carried in three internal bays, two lateral and one ventral

The aircraft also features the ability to cruise supersonically without afterburner ('supercruise'), 2D thrust vectoring nozzles for dramatically improved agility, and short takeoff and landing. The aircraft uses fly-by-wire, side-stick controls and features the very latest cockpit design.

### ARMAMENT

One long barrel 20mm 6 barrel rotary gun, with three internal bays for: the AIM 120 AMRAAM medium range, the AIM 9 Sidewinder Short-Range air-to-air missiles, the HAVE SLICK air-to-surface missiles, Joint Direct Attack Missiles, Tri Service Stand Off Attack Missiles, and Paveway laser guided bombs. There are also four under wing hard points.
Maximum fuel or weapons payload NA

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

| | |
|---|---|
| Wingspan | 13.56 m (44 ft 6 ins) |
| Length | 18.92 m (62 ft 1 in) |
| Height | 5 m (16 ft 5 ins) |

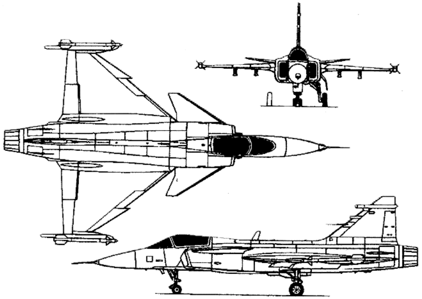
| | **F-22A** |
|---|---|
| Max level speed at height | Mach 2.2<br>1260 knots<br>2,333 kmh<br>1,450 kmh |
| Max level speed at sea-level | NA |
| Service ceiling | 19800 m<br>65000 ft |
| Required runway length | 3500 ft |
| Max Range: with max internal fuel | 1550 n miles<br>2870 km<br>1784 miles |
| Max Range: with drop tanks | NA |

Equipment for inflight refuelling is fitted.

Performance Table

# NEUTRAL FIGHTER

## JAS 39 GRIPEN



The JAS 39 Gripen is a remarkable achievement by a Swedish consortium to develop an aircraft to replace the Dracken and Viggen of the Swedish airforce, and for a lightweight export rival to the F16. The Gripen bears a resemblance to the EuroFighter 2000, and the Dassault Rafale with its agile canard delta shape and fly-by-wire controls. It is however a more economical aircraft, due to its single engine, and light weight.

The aircraft is smaller and half the weight of the Saab Viggen it is designed to replace yet can carry the same weight and number of weapons. Like the Viggen, the Gripen has also been designed for use on short-airstrips, with operation from road dispersal sights a key consideration. More than 30% of the airframe is made up of advanced materials, and its cockpit is an advanced design based on Multi-Function Displays. The aircraft is now being marketed by British Aerospace.

### ARMAMENT

One 27mm gun, with five hardpoints for: the AIM 120 AMRAAM medium range, the AIM 9 Sidewinder Short-Range air-to-air missiles, the RB75 Maverick air-to-surface missiles, the RB15F anti ship missile, sub munition dispensers, unguided rockets, cluster bombs, free fall, and retarded bombs.
Maximum external fuel or weapons payload is 4000 kg (8800 lb).

### TECHNICAL SPECIFICATIONS

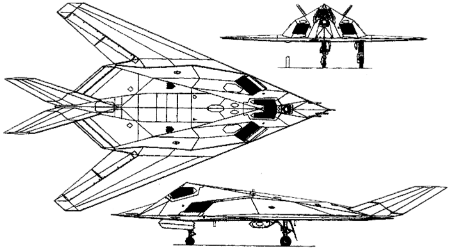
*DIMENSIONS*

| | |
|---|---|
| Wingspan | 8.4m (27 ft 6.7 in) |
| Length | 14.1m (46 ft 3 in) |
| Height | 4.5m (14 ft 9 in) |

| | **JAS 39 GRIPEN** |
|---|---|
| Max level speed at height | NA |
| Max level speed at sea-level | NA |
| Service ceiling | NA |
| Required runway length | 800 m<br>2625 ft |
| Max Range: with max internal fuel | NA |
| Max Range: with drop tanks | NA |

Performance Table

## LOCKHEED F-117A STEALTH FIGHTER



The F-117A was a result of the highly secret 'Have Blue' programme to develop aircraft that are virtually undetectable by radar and infra-red.

For several years the US Government tried to keep the existence of the F-117A an absolute secret. However, after the crashes of two aircraft, and the need to train pilots during daylight, plus the growing rumours about the aircraft's existence, the US airforce reluctantly released retouched photographs of the F-117A.

The Gulf war gave the F-117A an unprecedented opportunity to prove its worth. Operating at night without interference the aircraft was able to bomb high value targets with impunity and to great effect.

The solution to radar stealth had been locked away in a century-old set of equations by a Scottish physicist, James Clerk Maxwell. 3D computing had not developed sufficiently in the late 70s to predict all the possible radar reflections from an aircraft in flight. However, by the use of "faceting" (flat skin panels) the number of calculations could be kept to a minimum, hence the F-117A is made entirely of flat panels. The sharp delta shape also reduces radar reflections. The unusual jet pipe design helps to cool the exhaust so as to prevent infra-red detection, and missile "lock on".

### ARMAMENT

All weapons are carried internally in a large ventral bay. Precision guided weapons are carried such as the laser guided GBU10, GBU12 Paveway 2, and GBU27 Paveway 3. Air-to-air defensive missiles are carried by later variants.
Maximum weapons payload is 2270 kg (5000 lb).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

| | |
|---|---|
| Wingspan | 13.2 m (43 ft 4 in) |
| Length | 20.1 m (65 ft 11 in) |
| Height | 3.78 m (12 ft 5 in) |

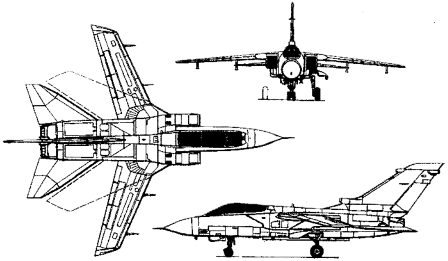
| | **F-117A** |
|---|---|
| Max level speed at height | Mach 0.95<br>545 knots<br>1,010 kmh<br>628 mph |
| Max level speed at sea-level | Mach 1<br>560 knots<br>1010kmh<br>646 mph |
| Service ceiling | NA |
| Required runway length | NA |
| Max Range: with max internal fuel | 1000 n miles<br>1860 km<br>1156 miles |
| Max Range: with drop tanks | No external fuel can be carried. |

Equipment for inflight refuelling is fitted.

Performance Table

# NATO STRIKE AIRCRAFT/BOMBERS

## PANAVIA TORNADO GR7



The Tornado was called the MRCA (multi role combat aircraft) by the consortium of British, German and Italian aircraft manufacturers who co-operated to produce this exceptional, low-level strike aircraft, and its reconnaissance, and air-defence variants.

The Tornado features continuously adjustable swing wings to allow it to achieve its ultra low level, high-speed strike mission, and sea-skimming anti-ship role with the German and Italian Navies. During the Gulf war the Tornado's of the RAF were given some of the most heavily defended targets to attack in the first few days.

The Tornado's small wings help it to avoid being deflected by wind gusts at levels as low as 50 feet off the ground. The pilot is assisted by onboard computers which can automatically fly the aircraft blind in an 'on the deck' terrain following mode down to an altitude of 200 feet.

### ARMAMENT

Two 27mm Mauser cannons, with seven hardpoints (wing hardpoints align with the fuselage on wing sweep) for: AIM 9 Sidewinder Short-Range air-to-air missiles, JP233 low-altitude anti airfield sub munitions dispensers, AGM88 HARM, and ALARM anti-radar missile, Sea Eagle and Kormoran anti-ship missiles, Paveway laser guided bombs, unguided rockets, cluster bombs, free fall, and retarded bombs. It can also carry the Matra Apache stand off missile, and has a nuclear capability.
Maximum external fuel or weapons payload is 9000 kg (19840 lb.).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

| | |
|---|---|
| Wingspan (extended) | 13.91 m (45 ft 7.5 in) |
| Wingspan (swept) | 8.6 m (28 ft 2.5 in) |
| Length | 16.72 m (54 ft 10.25 in) |
| Height | 5.95 m (19ft 6.25 in) |

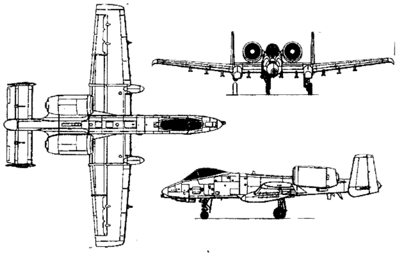
| | **GR7** |
|---|---|
| Max level speed at height | Mach 2.2<br>1260 knots<br>2338 kmh<br>1453 mph |
| Max level speed at sea-level | Mach 1.29<br>850 knots<br>1575 kmh<br>980 mph |
| Service ceiling | 15240m<br>50000 ft |
| Required runway length | 900m<br>2950ft |
| Maxiumum range with internal fuel | 1500 n miles<br>2780 km<br>1726 mile |
| Maxiumum range with drop tanks | 2100 n miles<br>3890 km<br>2420 miles |

Equipment for inflight refuelling is fitted.

Performance Table

# NATO STRIKE AIRCRAFT

## REPUBLIC A-10 THUNDERBOLT



Like many other American aircraft of its generation, the A10 was built after lessons learned in the Vietnam war, and was a radical and ground breaking design that moved away from the quick strike, fast-jet concepts of ground attack.

Though slow, the A10 is a heavily armoured machine, very agile at low altitude with a huge weapons carrying ability. Emphasis was placed on battlefield survival in the face of intense ground fire and the ability to loiter for long periods while choosing suitable victims. Pilots are protected by a titanium bathtub cockpit and, if necessary, the A10 can fly with an engine missing and remain aloft even after severe damage to wing surfaces.

Carried internally along the aircraft centre line is a rapid-fire, rotating barrel gun which fires high explosive and armour penetrating shells the size of pint milk bottles.

### ARMAMENT

One 30mm 7 barrel rotary gun. Rate of fire 2100-4200 rounds per minute. The A10 has eleven hardpoints for: the AIM 9 sidewinder short-range air-to-air missiles, the AGM62 Walleye, the Rockeye cluster bomb, and AGM65 Maverick air-to-surface missile, the AGM88 HARM anti radar missile, the AGM114 anti tank missile, laser guided bombs, GBU optronically guided bombs, BLU1 or BLU27 napalm bombs, CBU52 or CBU71 bomblet dispensers, unguided rockets, free fall, cluster, and retarded bombs, SUU23 20mm gun pods. Maximum external fuel or weapons payload is 7257 kg (16000 lb).

### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

| | |
|---|---|
| Wingspan | 17.53m (57 ft 6 in) |
| Length | 16.26m (53 ft 4 in) |
| Height | 4.4m (14ft 5.5 in) |

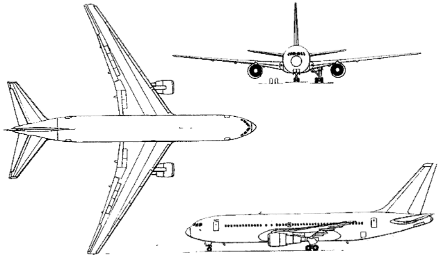
| | **A-10** |
|---|---|
| Max speed | 399 kts<br>740 kmh<br>460 mph |
| Service ceiling | NA |
| Required runway length | NA |
| Maximum range with internal fuel | NA |
| Maximum range with drop tanks | 2365 n miles<br>4382 km<br>2723 miles |
| Close air support radius of action including a 2 hour loiter | 250 n miles<br>463 km<br>288 miles |

Equipment for inflight refuelling is fitted.

Performance Table

# NATO SUPPORT AIRCRAFT

## BOEING E9 JSTARS



The JSTARS (Joint Surveillance Target Attack Radar System) is carried on the E9 which is based on the Boeing 767* airliner and is designed to operate in conjunction with and to enhance the capabilities of the E3 and E767 AWACS aircraft. The AWACS aircraft with their rotating saucer type radars are excellent for detecting airborne threats and ships at sea but have only limited capability for the detection and tracking of ground vehicles and troop movements.

The surveillance equipment and computers are able to monitor movements on the ground deep within enemy territory while flying in heavily defended airspace, just as in AWACS, and are able to vector attack aircraft onto threats. Data can be passed to other JSTARS, or AWACS aircraft, attack aircraft, and to ground commanders. The original E8 was rushed into service for the Gulf war while still under development and proved extremely useful for directing the flights of thousands of aircraft and the movements of troops.

The use of airborne control aircraft allows NATO commanders a very fluid real time approach to control of battlefield assets, and all tactical considerations.

### ARMAMENT

Wing tip ECM pods, and chaff/flare dispensers are carried. In war time the aircraft would be protected by a combat air patrol.

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### TECHNICAL SPECIFICATIONS

*Dimensions*

| | |
|---|---|
| Wingspan | 47.57m (156 ft 1 in) |
| Length | 48.51m (159 ft 2 in) |
| Height | 15.85m (52 ft) |

| | **E9 JSTARS** |
|---|---|
| Max speed | N/A |
| Cruising speed | Mach 0.8<br>535 kts<br>991 kmh<br>616 mph |
| Service ceiling | 13,100 m<br>43,000 ft |
| Required runway length | 2,774 m<br>9,100 ft |
| Maximum range with internal fuel | 5,000 n miles<br>9,260 km<br>5,754 miles |
| Endurance at radius | 7 hours<br>1,000 n miles<br>1,852 km<br>1,151 miles |

Equipment for inflight refuelling is fitted.

Performance Table

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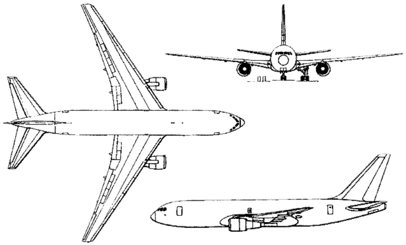
* EF2000 Game only.

# NATO SUPPORT AIRCRAFT

## BOEING R767



The R767 is based on the same Boeing 767-200 airframe as the E767. The aircraft is fitted with a combined boom and drogue refuelling probe. US Airforce aircraft use the boom for refuelling, Navy and Marines aircraft use the same drogue refuelling method as the RAF and Royal Navy.

The twin turbofan Boeing airframe is more economical to use than previous refuelling tankers based on the triple engine McDonnel Douglas DC10. This combined with the huge amount of onboard fuel allows the aircraft to remain on refuelling station for longer, or to refuel a greater number of aircraft.

Future versions of the R767 will be based on the 300 series airliner which features a stretched fuselage and is able to carry a greater weight of fuel.

### ARMAMENT

The R767 is equipped with ECM, and chaff/flare dispensers.

### TECHNICAL SPECIFICATIONS

*Dimensions*

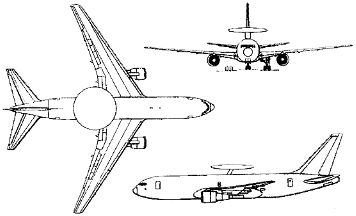
| | |
|---|---|
| Wingspan | 47.57m (156 ft 1 in) |
| Length | 48.51m (159 ft 2 in) |
| Height | 15.85m (52 ft) |

| | **R767** |
|---|---|
| Cruising speed | Mach 0.8<br>535 kts<br>991 kmh<br>616 mph |
| Service ceiling | 13,100 m<br>43,000 ft |
| Required runway length | 2,774 m<br>9,100 ft |
| Maximum range with internal fuel | 5,000 n miles<br>9,260 km<br>5,754 miles |

Equipment for inflight refuelling is fitted.

Performance Table

## BOEING E767 SENTRY



Based on the extended range versions of the Boeing 767/200 Airliner, the E767 carries uprated and enhanced versions of equipment originally fitted in the Boeing 767 based E3 AWACS (airborne warning and control system) aircraft. Originally inspired by a Japanese AWACS requirement, the E767 has since gone into service with the US Airforce and other military users.

The saucer like radome mounted on the rear fuselage rotates through 360 degrees at a constant 6 rpm, and is able to pick up targets as small as cruise missiles flying rapidly at low level over water or land. To avoid air turbulence problems caused by the large radome in the tanker aircraft's slip stream the E767 airborne refuelling point is on the port outer wing. With a range of 370 km (230 miles) and covering all altitudes from ground to stratosphere the radar system can locate and track multiple aircraft and ship targets with automatic interrogation. Computers on board can pass digital information to other AWACS, or JSTARS aircraft, directly to attacking fighters or strike aircraft, and also to forces on the ground. It is even possible for an air interception officer on the AWACS aircraft to take positive control of a fighter 100 miles away during a live intercept, and to see on his console what the fighter pilot's radar is displaying.

### ARMAMENT

The E767 is equipped with extensive ECM, and chaff/flare dispensers. The aircraft is unarmed but in wartime would be protected by a CAP (combat air patrol). Radars can be turned off and surveillance or tracking continued in the stealthy infrared band.

### TECHNICAL SPECIFICATIONS

*Dimensions*

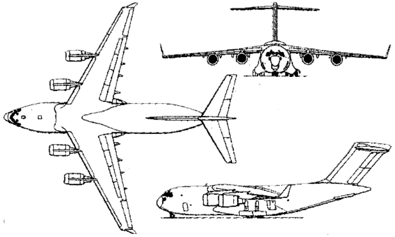
| | |
|---|---|
| Wingspan | 47.57m (156 ft 1 in) |
| Length | 48.51m (159 ft 2 in) |
| Height | 15.85m (52 ft) |

| | **E767** |
|---|---|
| Max speed | NA |
| Cruising speed | Mach 0.8<br>535 kts<br>991 kmh<br>616 mph |
| Service ceiling | 13,100 m<br>43,000 ft |
| Required runway length | 2,774 m<br>9,100 ft |
| Maximum range with internal fuel | 5,000n miles<br>9,260 km<br>5,754 miles |
| Endurance at radius | 7 hours.<br>1,000 n miles,<br>1,852 km,<br>1,151 miles |
| Maximum endurance with inflight refuelling | 22 hours. |

Equipment for inflight refuelling is fitted

Performance Table

## LOCKHEED C-17 GLOBEMASTER



The US Airforce normally moves freight in peacetime and war, through a hub and spoke system. Large transports such as the C-5 Galaxy carry a cargo to the destination, where a smaller transporter capable of landing on rough airstrips, usually the C-130 Hercules, will distribute the cargo to the exact location. However, the C-130 is not able to carry large items of equipment such as main battle tanks.

Against this background the US Airforce realised it had a need for an aircraft capable of carrying the large, heavy loads handled by the C-5 with its intercontinental range, able to fly direct from the USA and land at the battlefront on hastily prepared airstrips like the C-130.

The C-17 Globemaster won the competition to fulfill this role. Despite Government changes of plan and escalating costs, the aircraft entered service in 1994. The first US transport to combine fly by wire, glass screen instruments, and a HUD (Head Up Display), the C-17 is partly constructed from composite structures. The wings employ tip mounted winglets for cruise efficiency, and the four turbo fans blow their exhaust stream through and across large double-slotted flaps for a superb STOL (short take off and landing) performance.

The fuselage diameter is equal to that of the C-5 Galaxy, the hold measures 26.82 metres (88 feet) long, and 5.49 metres (18 feet) wide, being able to swallow main battle tanks through the rear ramp/door.

The C-17 is compatible with LAPES (low altitude parachute extraction system). Pallets containing up to 60,000 lb of cargo each can be dragged from the rear of the cargo bay by chutes while the aircraft is kept automatically at a constant ten feet altitude. Surprisingly this is a very effective delivery method when the ground is too rough to land on!

### ARMAMENT

Chaff/Flare dispensers and ECM pods can be fitted. Maximum payload is 76,657 kg (169,000 lb).

### TECHNICAL SPECIFICATIONS

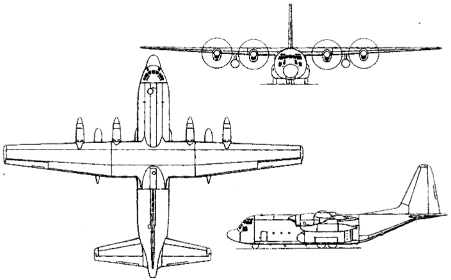
*DIMENSIONS*

| | |
|---|---|
| Wingspan | 50.29m (165 ft) |
| Length | 53.04m (174 ft) |
| Height | 16.79m (55 ft 1 in) |

| | **C-17** |
|---|---|
| Max speed | NA |
| Cruising speed | Mach 0.77<br>515 kts<br>954 kmh<br>593 mph |
| Service ceiling | 13,715 m<br>45,000 ft |
| Required runway length | 915 m<br>3000 ft |
| Maximum range with internal fuel | 4,700 n miles<br>8,704 km<br>5,408 miles |
| Equipment for inflight refuelling is fitted. | |

Performance.Table

# LOCKHEED HERCULES C130



In 1950 the US Airforce became involved in the Korean war and found that its C119 Flying Boxcar tactical transport which had only just entered service lacked adequate range and payload carrying ability. The US Airforce issued a requirement calling for a transport with the ability to carry ninety two men over a radius of 1,100 nautical miles, 2,038 kilometres, 1,267 miles, or able to carry a freight payload of 30,000 lb over a radius of 950 nautical miles, 1,760 kilometres, 1,093 miles. The aircraft must have side and rear doors capable of being opened in flight and be able to fly slow enough to deploy paratroopers or parachute equipped freight from these doors.

Provision had been made for the C130 to use the RATO (rocket assisted take off) system for dramatically short take offs. The aircrafts range with internal fuel was improved, it was later able to be fitted with two non-jettisonable external fuel tanks between the engine nacelles.

The C130 has over the last forty years taken on the tough role of the much loved C47 Dakota.

### ARMAMENT

The Hercules is not armed, though usualy carries flare launchers used to decoy infrared missiles.
Maximum payload is 17,555 kg (38,702 lb).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

| | |
|---|---|
| Wingspan | 40.41m (132 ft 7 in) |
| Length | 29.79m (97 ft 9 in) |
| Height | 11.66m (38 ft 3 in) |

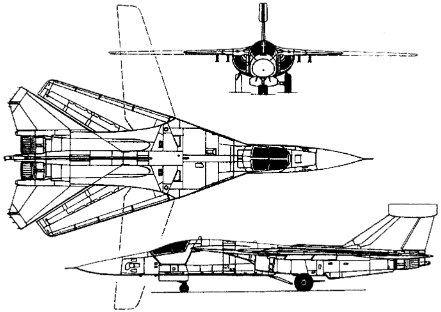
| | **C130** |
|---|---|
| Max speed | 335 kts<br>621 kmh<br>386 mph |
| Cruising speed | 325 kts<br>602 kmh<br>374 mph |
| Service ceiling | 7,010m<br>23,000 ft |
| Required runway length | 1,311m<br>4,300 ft |
| Maximum range with Internal fuel | 2,100 n miles<br>3,890 km<br>2,418 mls |
| Maximum range with drop tanks | 4,745 n miles<br>8,793 km<br>5,464 miles |

Equipment for inflight refuelling is fitted.

Performance Table

# NATO SUPPORT AIRCRAFT

## LOCKHEED EF-111 RAVEN



Entering service in 1967, the EF-111 had a difficult start to life when three of the first six aircraft were lost in Vietnam within the first few days of the type's combat debut, amid Government criticism of escalating costs and complexity.

The EF-111 has shown in service that it was worth all the extra costs, an aircraft way ahead of its time with its swing wings, and automated ground-hugging attack capability. For many years the EF-111 was considered to be the most effective all-weather strike aircraft in the world.

The EF-111 has consistently proved its ability to deliver precision ground attack munitions in any weather. The EF-111 was undoubtedly the 'improved tactics' mentioned in briefings during the Gulf War being the only aircraft able to drop the huge GBU28 4700 lb laser guided bomb.

The EF-111 featured in the game is an all weather electronic counter measures variant, used to provide disruptive jamming for Anti-AWACS, interdiction and other strike missions.

### ARMAMENT

One large internal weapons bay, used for counter-measures equipment in the EF-111 Raven. No other weapons are carried.
Maximum external fuel or weapons payload is 12290 kg (31500 lb).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

| | |
|---|---|
| Wingspan (spread) | 19.2m (63 ft ) |
| Wingspan (swept) | 9.74m (31ft 1.5 in |
| Length | 22.4m (73 ft 6 in) |
| Height | 5.22m (17ft 1.5 in) |

| | **EF-111** |
|---|---|
| Max level speed at height | Mach 2.2<br>1260 knots<br>2335 kmh<br>1450 mph |
| Max level speed at sea-level | Mach 1.2<br>790 knots<br>1470 kmh<br>910 mph |
| Service ceiling | 18300 m<br>60000 ft |
| Required runway length | 914m<br>3000 ft |
| Max Range: with max internal fuel | 3304 n miles<br>6115 km<br>3800 miles |
| Max Range: with drop tanks | NA |

Equipment for inflight refuelling is fitted.

Performance Table

# RUSSIAN AIRCRAFT

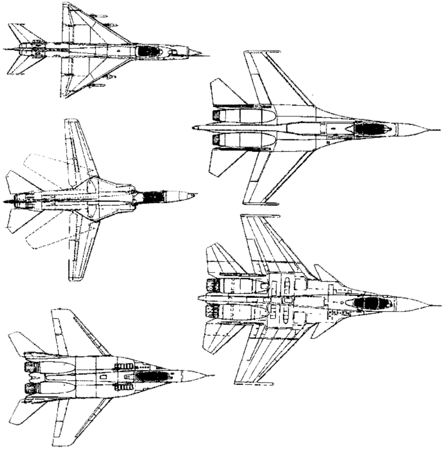
## RUSSIAN FIGHTERS

Following the collapse of the USSR, the Russian aerospace industry fell into sharp decline, with factories being converted to produce anything from kitchen sieves to knitting machines. However, there were eager customers for the Russian's low-priced, high-performance aircraft, and before the turn of the century, production was back in full swing. Buyers include many regimes hostile to NATO, and profits are being ploughed back into research. The West is once more under threat, in both a commercial and military sense.

A favourite export model is the Sukhoi SU-35 the threat which EuroFighter is designed to beat. However, new developments in avionics, engines and weaponry have given the plane remarkable performance. . . an aircraft worthy of respect, even by the EF2000 pilot.

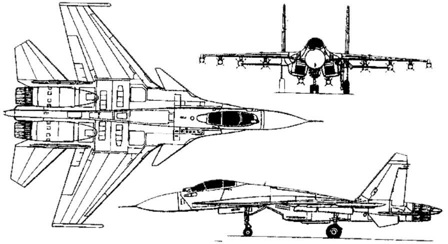
At the outbreak of war, rumours quickly spread of a new generation of Russian Super-Fighter based on the MIG-1.42, later designated MIG-33 and code-named Flashback. Satellite photography suggests the presence of a new type in the North Cape area, but combat reports are non-existent – possibly because no NATO pilot ever survived an encounter.

In contrast, the Russians hold a great many ageing planes in reserve, including the venerable MIG-21, which is relegated to back-line defence and close air-support in times of great need. Hopelessly out-of date in 2010, they are theoretically easy game for an EF2000, but thanks to upgraded avionics and sheer numbers, are still proving dangerous in close combat.



Anti-clockwise from top-left: MIG-21, MIG-27, MIG-29, SU-35, SU-27

## SUKHOI SU-35



An impressive single-seat all-weather counter-air fighter and ground attack aircraft, derived from the SU-27, with an uprated airframe containing a high proportion of carbon-fibre and aluminium-lithium alloy. The engines, avionics and armaments are also improvements on those originally installed in the SU-27.

The SU-35 features fly-by-wire, relaxed static instability, and three-dimensional thrust vectoring, all of which give the aircraft tremendous agility. It incorporates state-of-the-art ECM in wing-tip pods, allowing improved survivability in electronic warfare environments. The N011 multi-mode radar is effective at ranges up to 250 miles, and has the ability to engage six targets simultaneously. Some models also feature a rearward facing radar. Like EuroFighter, the SU-35 is equipped with TIALD, providing pin-point precision in the delivery of laser-guided weapons.

Enormous power is delivered by two Saturn/Lyulka AL-3 1 FM turbofans, developing 30,865 lb st each with afterburning – almost one third more power than the standard EuroFighter engine.

### ARMAMENT

One 30 mm GSh-30 gun, plus hard-points for 14 stores, including R-27 (AA-10 Alamo-A/B/C/D), R-40 (AA-6 Acrid), R-60 (AA-8 Aphid), R-73A (AA-1 Archer) and R-77 (AA-12) AMRAAM air-to-air missiles, Kh-2iML (AS-10 Karen), Kh-25MP (AS-12 Kegler), Kh-29 (AS-14 Kedge) and Kh-31 (AS-17 Krypton) air-to-surface missiles, KAB-500 bombs and rocket packs. Maximum weapons payload load is 8,000 kg (17,635 lb).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

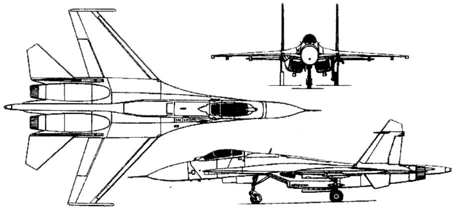
| | |
|---|---|
| Wing span: | 15.00 m (49 ft 2.5 in) |
| Length: | 22.00 m (72 ft 2.4 in) |
| Height: | 6.00 m ( 19 ft 8 in) |

| | **SU-35** |
|---|---|
| Max level speed at height | Mach 2.35<br>1,349 knots<br>2,500 km/h<br>1,553 mph |
| Max level speed at sea-level | Mach 1.18<br>737 knots<br>1,364 km/h<br>848 mph |
| Service ceiling | 18,000 m<br>59,055 ft |
| Balanced runway length | 600 m<br>1,970 ft |
| Range: with max internal fuel | 2,160 nm +<br>4,000 km +<br>2,485 miles + |

Equipment for inflight refuelling is fitted

Performance Table

# SUKHOI SU-27 AND SU-33



The SU-27 was built to replace the YAK-28, SU-15, and the TU-28 Interceptors. The fighter was intended to fulfil an escort role for the SU-24 deep penetration strike aircraft during which operations the SU-27 was expected to be able to engage F-15 and F-16 fighters.

The SU-27 was given exceptional range on internal fuel as the SU-24 was not capable of inflight refuelling, an error rectified in later versions of the aircraft. The SU-27 is controlled with an analogue fly by wire system and features exceptionally powerful engines rated at 27550 lbs thrust with afterburning. The long swooping nose, widely spaced engine pods, and twin-tailed design resembles the MIG-29 which was designed at the same time.

The pilot has a helmet mounted target designator which is integrated with the fire control system and operates a slave laser range finder and infrared tracker. The onboard computers can return the aircraft to level flight from any angle if the "panic button" is used.

The SU-33 is the latest navalised version of the SU-27, and has canards like the SU-35.

### ARMAMENT

One 30mm gun, and ten hardpoints for: the R27R (AA10 ALAMO A),R27T (AA10 ALAMO B),R27ER (AA10 ALAMO C), R27ET (AA10 ALAMO D), R73A (AA11 ARCHER), R60 (AA8 APHID), and R33 (AA9 AMOS) air to air missiles. Bombs, and unguided rockets can be carried in a secondary air-to-ground role.
Maximum external weapons payload is 6000 kg (13228 lb).

### TECHNICAL SPECIFICATIONS

*Dimensions*

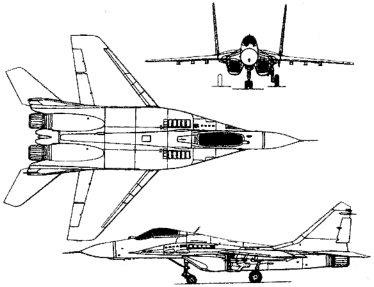
| | |
|---|---|
| Wingspan | 14.7m (48 ft 2.75 in) |
| Length | 21.93m (71 ft 11.5 in ) |
| Height | 5.93m (19 ft 5.5 in ) |

| | **SU-27** |
|---|---|
| Max level speed at height | Mach 2.35<br>1,349 knots<br>2,500 km/h<br>1,553 mph |
| Max level speed at sea-level | Mach 1.1<br>635 knots<br>1,176 km/h<br>730 mph |
| Service ceiling | 18,000 m<br>59,055 ft |
| Required runway length | 600 m<br>1,970 ft |
| Range: with max internal fuel | 2,159 nm<br>4,000 km<br>2,486 miles |

Performance Table

# RUSSIAN FIGHTERS

## MIKOYAN GUREVICH MiG-29



The MIG-29 was a result of a 1972 Soviet airforce requirement for a fighter to replace the MIG-21, and SU-15 air combat fighters, plus a secondary role replacing the MIG-23, and SU-17 ground attack aircraft. Mikoyan Gurevich aimed to produce an aircraft that was at least as good as the F-15.

As most Russian aircraft are designed to operate from rough airfields when necessary, the MIG-29 has a very unusual door system which blanks the large under-fuselage intakes from mud and ice thrown up from the front wheel. From the MiG-29M onwards this system was deleted because of weight, and replaced by a retractable grille system.

The radar laser rangefinder and infra-red detectors are all linked together by the fire control system and work with the pilot's helmet mounted target designator as on the SU-27.

In the late 80's the MIG-29 competed against the SU-27 for more Russian airforce orders, but lost the competition through not having enough range, and weapon capability. The MIG-29M was developed after this competition with improved range, performance, and weapon carrying ability.

### ARMAMENT

One 30 mm gun. The MIG-29 has six hardpoints (eight on the MIG-29M) for: the R27R (AA10 ALAMO A), R60MK (AA8 aphid), R73E (AA11 archer), air-to-air missiles, KMGU-2 submunitions dispensers, napalm, free fall and unguided rockets. Maximum external weapons payload is 3000 kg (6614 lb).

### TECHNICAL SPECIFICATIONS

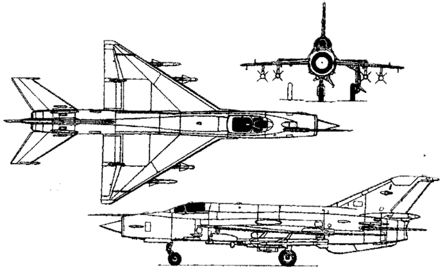
*DIMENSIONS*

| | |
|---|---|
| Wingspan | 11.36m (37 ft 3.25 in) |
| Length | 17.32m (56 ft 9.85 in ) |
| Height | 4.73m (15 ft 6.2 in ) |

| | **MIG-29** |
|---|---|
| Max. level speed at height | Mach 2.3<br>1319 knots<br>2445 kmh<br>1519 mph |
| Max. level speed at sea level | Mach 1.06<br>700 knots<br>1300 kmh<br>805 mph |
| Service ceiling | 17000 m<br>55775 ft |
| Required runway length | 600 m<br>1970 ft |
| Maximum range with internal fuel | 810 n miles<br>1500 km<br>932 miles |
| Maximum range with drop tanks | 1565 n miles<br>2900 km<br>1800 miles |

Performance Table

## MIKOYAN GUREVICH MiG-21



The MIG-21 was designed after lessons learned by the Russians during the Korean war. Intended to fulfil the same air superiority mission as the contemporary American F-104 Starfighter, and the French Mirage, the MiG-21 adopted a different design layout to either of these aircraft. Initially the Mikoyan Gurevich design team could not decide between the swept wing prototype and the delta wing prototype. Eventually after much flight testing they selected the delta wing prototype on the grounds that it would carry more fuel and have more development potential.

The MIG-21 has been produced in more versions and in far greater numbers than any aircraft since the Second World War, and is probably the best known Soviet aircraft. Originally an interceptor the designers kept the weight of fuel carried to a minimum to give the aircraft the best rate of climb possible. This lack of internal fuel and the inability to carry more than three small drop tanks, has left the MIG-21 short on range. The MIG-21 has been used by all the airforces of the ex-Eastern Bloc, and many others including airforces as far apart as Finland and China. Despite the age of this fighter design, its small size, agility, and speed make it a difficult target and a dangerous opponent. Because the radar is situated in the inlet duct, the MIG-21 cannot be equipped with the latest radars, and even the most up-to-date versions have very limited all weather capability.

### ARMAMENT

One 30mm gun and four wing hardpoints for: the R3 (AA2 ATOLL), and R3 (AA2-2 advanced ATOLL) air-to-air missiles, free fall bombs, and unguided rockets.
Maximum external weapons payload is 1500 kg (3307 lb).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

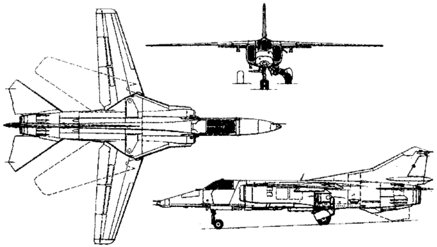
| | |
|---|---|
| Wing span: | 7.15m (23ft 5.5in) |
| Length | 15.76m (51 ft 8.5 in ) |
| Height | 5m (14 ft 9 in ) |

| | **MIG-21** |
|---|---|
| Max level speed at height | Mach 2.1<br>1,203 knots<br>2,230 km/h<br>1,385 mph |
| Max level speed at sea-level | Mach 1.06<br>702 knots<br>1,300 km/h<br>807 mph |
| Service ceiling | 15,250 m<br>50,035 ft |
| Balanced runway length | 1,200 m<br>3,940 ft |
| Required runway length | 600 m<br>1970 ft |
| Range: with max internal fuel | 593 nm<br>1,100 km<br>683 miles |
| Range: with drop tanks | 971 nm<br>1,800 km<br>1,118 miles |

Performance Table

# RUSSIAN STRIKE AIRCRAFT

## MIKOYAN GUREVICH MiG-27



The MiG-27 is an improved version of the close air support and ground attack MiG-23 swing-wing fighter bomber, designed to fly at a slower speed, and lower altitude, carrying a larger weapon load with better radar and precision missile aiming equipment. The pilot is seated higher for better visibility, and enjoys the protection of improved armour. Navigation and attack systems have been included in the design to give the MiG-27 an all weather attack capability. The nose has a flattened glass underside, which contains the TV tracker unit and laser rangefinder/designator.

The aircraft is able to carry an under fuselage gun pack that has depressable barrels, so the aircraft can strafe the ground while in level flight. Alternatively a battlefield reconnaissance pod can be fitted. The MiG-27 has also been operated from Soviet aircraft carriers.

### ARMAMENT

One 23mm twin barrel gun, with seven hardpoints for: the R3 (AA2 ATOLL), and R60 (AA8 APHID) air-to-air missiles, KH23 (AS7 KERRY), KH25ML (AS10 KAREN), and KH25MP (AS12 KEGLER), air-to-surface missiles, AS9 (KYLE) anti radar missiles, free fall bombs, napalm, and unguided rockets.
Maximum external fuel and weapons payload is 4000 kg (8818 lb).

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### TECHNICAL SPECIFICATIONS

*DIMENSIONS*

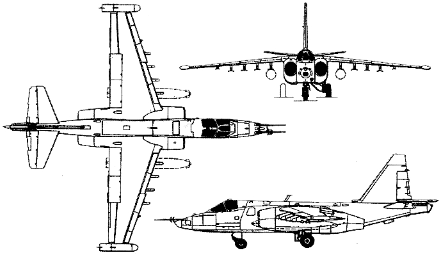
| | |
|---|---|
| Wingspan (spread) | 13.96m (45 ft 9.8 in) |
| Wingspan (swept) | 7.78m (25 ft 6.25 in) |
| Length | 17.08m (56 ft 0.25 in ) |
| Height | 5m (16 ft 5 in ) |

| | **MIG-27** |
|---|---|
| Max level speed at height | Mach 1.77<br>1,017 knots<br>1,885 km/h<br>1,170 mph |
| Max level speed at sea-level | Mach 1.1<br>635 knots<br>1,176 km/h<br>730 mph |
| Service ceiling | 14,000 m<br>45,930 ft |
| Required runway length | 950 m<br>3,120 ft |
| Range: with max internal fuel | 242 nm<br>450 km<br>280 miles |
| Range: with drop tanks | 1,737 nm<br>3,220 km<br>2,000 miles |

Performance Table

# RUSSIAN STRIKE AIRCRAFT/BOMBERS

## SUKHOI SU25/39



The SU-25 follows the design of the trail blazing A10 of the USA. The layout is different from the A10 but similar in many areas including the pilot's seating within a "bathtub" of titanium armour, and the ability to operate from rough frontline airstrips. All fuel lines are shrouded in fire resistant foam, the engines are enclosed in stainless steel boxes. Early aircraft were very basic in their flying controls but of greater performance than the A10 due to lighter unladen weight and higher performance engines.

Later versions (SU-28), like the A10 have the nose wheel offset to port to allow the gun to be centre line mounted in the front fuselage. Targeting equipment has been fitted, including a magnifying TV camera, and targets are picked out on the pilot's headup display. Infrared sensors are fitted for all weather attack.

The latest version is designated SU-39 and carries much more fuel, better sensors, and has much improved performance, being optimised for battlefield and anti-tank attacks.

### ARMAMENT

One 30mm twin barrel gun. The SU25 has ten hardpoints for: two R3 (AA2 ATOLL), or R60 (AA8 APHID), defensive air-to-air missiles, KH58 (AS11 KITTEN) anti radar missiles, freefall and retarded bombs, laser guided bombs, and unguided rockets SPPU22 gun pods each containing one 23 mm twin barrel gun with depressed barrels for strafing attacks. Maximum external weapons payload is 4400kg (9700 lb).

### TECHNICAL SPECIFICATIONS

*Dimensions*

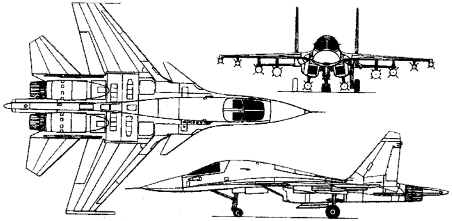
| | |
|---|---|
| Wingspan | 14.36m (47 ft 1.4 in) |
| Length | 15.53m (50 ft 11.5 in ) |
| Height | 4.8m (15 ft 9 in ) |

| | **SU25** |
|---|---|
| Max level speed | 526 knots<br>975 kmh<br>606 mph |
| Service ceiling | 7000 m<br>22965 ft |
| Required runway length | 1300 m<br>4265 ft |
| Maximum range with internal fuel | 515 n miles<br>950 km<br>590 miles |
| Maximum range with drop tanks | 565 n miles<br>1050 km<br>650 miles |

Performance Table

# RUSSIAN STRIKE AIRCRAFT

## SUKHOI SU-34



The SU-34 is a development of the SU-27 but intended for the long range strike and ground attack role. Its airframe is similar but has a wider nose with side by side seating in a similar fashion to the F-111 and small canard foreplanes. The tail cone now houses a rearward facing warning radar. The aircraft is believed to carry defensive rearward facing air-to-air missiles.

The SU-34 has a new terrain following and navigation/attack radar combined with a modern multi function display cockpit. While the foreplanes are sited in the same position as on the SU-35 fighter, the main undercarriage has noticeably bigger all terrain twin wheel gear units. Internal fuel tankage is large by western standards.

### ARMAMENT

One 30mm gun. The SU-34 has ten hardpoints for:R73 (AA11 archer), and R77 (AA12 AMRAAM type) air-to-air missiles, unspecified precision guided air to surface missiles, KAB 500 laser guided bombs, cluster bombs, free fall and retarded bombs. nuclear bomb and missile carrying ability.
Maximum external fuel or weapons payload is unknown, but likely to exceed that of the SU-27/SU-35.

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### TECHNICAL SPECIFICATIONS

*Dimensions*

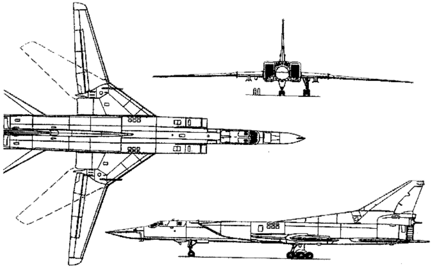
| | |
|---|---|
| Wingspan | 14.7m (48 ft 2.75 in) |
| Length | 22.4m (73 ft 6 in) |
| Height | 5.93m (19ft 5.5 in) |

| | **M SU-34** |
|---|---|
| Max level speed at height | Mach 1.8<br>1035 knots<br>1915 kmh<br>1190 mph |
| Max level speed at sea level | Mach 1.15<br>695 knots<br>1,287 kmh<br>800 mph |
| Service ceiling | 18000 m<br>59055 f |
| Required runway length | NA |
| Maximum range with internal fuel | 2160 n miles<br>4000 km<br>2485 miles |
| Maximum range with drop tanks | NA |

Performance Table

# RUSSIAN STRIKE AIRCRAFT/BOMBERS

## TUPOLEV TU22M



The TU22M is a considerably reworked version of the TU22 supersonic bomber which had proved very disappointing in range and airfield performance. The turbojet engines were changed for more economical turbofans, and moved from their tail fin side by side location to a fighter like position side by side in the rear fuselage fed by side mounted wedge intakes.

The outer panels of the wings are of variable geometry (swing wing) to reduce the takeoff run, and are equipped with lift improving flaps, and full span slats.

The radar operated tail gun was aerodynamically smoothed out to reduce drag, and a rotary missile launcher added within the ventral weapons bay.

The aircraft is used for strategic nuclear attack by the Airforce, and for electronic reconnaissance, and anti shipping strikes by the Navy. The TU22M was originally thought to be designated the TU26 by Western observers, however after the Cold War eased in the early 90's this was found to be wrong.

### ARMAMENT

Two 23mm radar controlled guns in a turret. The TU22M has four hardpoints and a ventral weapons bay for: The AS4 (Kitchen) long range air to surface missile, free fall nuclear or conventional bombs.
Maximum weapons payload is 12000 kg (26455 lb).

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### TECHNICAL SPECIFICATIONS

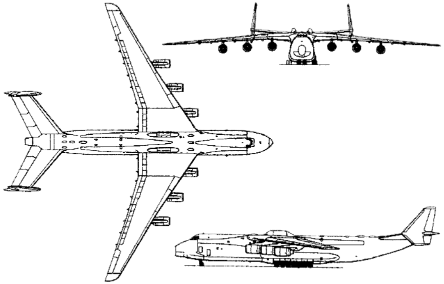
*Dimensions*

| | |
|---|---|
| Wingspan | 34.3m (112 ft 6.5 in) |
| Wingspan (swept) | 23.4m (76 ft 9.25 in) |
| Length | 39.6m (129 ft 11 in ) |
| Height | 10.8m (35 ft 5.25 in ) |

| | **TU22M** |
|---|---|
| Max level speed at height | Mach 2<br>1146 knots<br>2125 kmh<br>1320 mph |
| Max level speed at sea level | Mach 0.86<br>567 knots<br>1050 kmh<br>652 mph |
| Service ceiling | 18000 m<br>59055 ft |
| Required runway length | 2000 m<br>6560 ft |
| Maximum range with internal fuel | 1188 n miles<br>2200 km<br>1365 miles |
| Maximum range with drop tanks | 6476 n miles<br>12000 km<br>7457 miles |

Performance Table

## ANTONOV AN225



The AN225 is the world's biggest aircraft, and was the first to fly weighing more than 1,000,000 lb.The aircraft is based on the four turbofan Antonov 124 with the addition of two extra engines, longer wings, and fuselage. The tail surfaces were replaced by substantially larger horizontal stabilizers and twin vertical tails placed widely apart so as to receive adequate air flow when carrying outsize loads on top of the fuselage, roof rack fashion!

Behind the wing and above the hold there is a cabin with seating for sixty to seventy people.

In order to cope with the huge weight of the aircraft on landing, the AN225 is equipped with twin steerable nose undercarriage mounted side by side, and no less than seven independently retracting twin wheel main legs per side. In order to help loading, the aircraft nose undercarriage can retract while on the ground allowing the aircraft to settle on to two extendable feet. The AN225 was planned to be enlarged further with a total of eight engines for use as an airborne launcher for European reusable space planes.

### ARMAMENT

ECM pods and Chaff/Flare dispensers can be carried. Maximum payload carried internally or externally is 250,000 kg (551,150 lb).

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### TECHNICAL SPECIFICATIONS

*Dimensions*

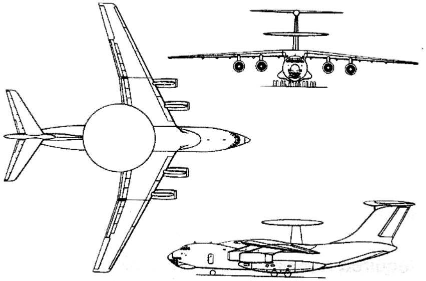
| | |
|---|---|
| Wingspan | 88.4m (290 ft) |
| Length | 84m (275 ft 7 in) |
| Height | 18.2m (59 ft 8.5 in) |

| | **AN225** |
|---|---|
| Max speed | NA |
| Cruising speed | Mach 0.64<br>432 kts<br>800 kmh<br>497 mph |
| Service ceiling | NA |
| Required runway length | 3,500 m<br>11,485 ft |
| Maximum range with internal fuel | 8,310 n miles<br>15,4000 km<br>9,570 miles |
| Maximum range with full (internal) load on internal fuel | 2,425 n miles<br>4,500 km<br>2,795 miles |
| Maximum range with drop tanks | not fitted |

Performance Table

# RUSSIAN SUPPORT AIRCRAFT

## BERIEV A50



A development of the IL76 airframe, the A50 is altered and fitted out by Beriev. The tail doors and cargo deck are replaced by comprehensive electronics and seating for a crew of fifteen. As in Western AEW (airborne early warning aircraft), a large rotating "saucer" radome has been added on twin struts on top of the aircraft fuselage. This radome is capable of locating and tracking aircraft through 360 degrees over land or water. The A50 is not fully developed. Due to the weight of equipment on board, the aircraft cannot take off with a full fuel load and has great difficulty refuelling in flight due to buffeting caused by the radome in a tanker's slip stream. As a result the A50 is short on endurance. Furthermore the lack of a crew rest area and proper toilet/galley facilities ensures early crew fatigue.

Due to economic shortages during the breakup of the USSR the production rate slowed down with the result that the modern Russian Airforce has been hampered by an insufficient number of AEW aircraft on occasion to control available resources. The A50 will almost certainly be developed further.

### ARMAMENT

The A50 is fitted with wing tip ECM pods and chaff/flare dispensers.

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### TECHNICAL SPECIFICATIONS

*Dimensions*

| | |
|---|---|
| Wingspan | 50.5m (165 ft 8 in) |
| Length | 46.59m (152 ft 10.5 in) |
| Height | 14.76m (48 ft 5 in) |

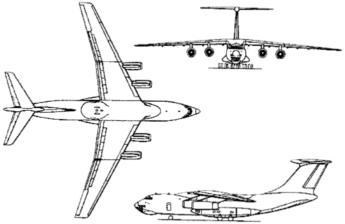
| | **A50** |
|---|---|
| Max speed | Mach 0.68<br>459 kts<br>850 kmh<br>528 mph |
| Cruising speed | Mach 0.64<br>432 kts<br>800 kmh<br>497 mph |
| Service ceiling | 14,500 m<br>47,570 ft |
| Required runway length | 850 m<br>2790 ft |
| Maximum range with internal fuel | Unknown but considerably less than the IL76 |
| Maximum range with drop tanks | Not equipped |

Equipment for inflight refuelling is fitted but virtually unusable due to aerodynamic turbulence.

Performance Table

# RUSSIAN SUPPORT AIRCRAFT

## ILYUSHIN IL76/78



Inspired by the American C141 Star lifter in shape and layout, the IL76 was however designed to meet much tougher requirements placed by the Soviet airforce in the late 1960's. The new transport must be able to carry 40,000 kg (88,183 lb) a distance of 2,698 nautical miles, 5,000 kilometres, 3,107 miles in less than six hours. It must also be able to operate in all weathers, night and day in the worst weather that the far flung parts of Arctic Russia and Siberia could muster. Furthermore the aircraft must be able to land and take off from rough airstrips that might be no more than an expanse of grass or compacted snow! The wings carry high lift devices for an impressive short field performance, including full span slats, and triple slot flaps over 75% of the span. The success of the IL76 airframe is such that a tanker version called the IL78 has been developed. Each aircraft carries three refuelling drogues which are trailed from pods fitted under each wing outer panel and one on the port side of the rear fuselage. The pods use a windmill ram air powered pump to deliver fuel at a rate far above any Western system for very quick aerial "pit-stops". The IL76/78 has further become the basis of the IL76 flying command post and the Beriev A50 Airborne early warning aircraft, and has been bought by military and civil users in both East and the West.

### ARMAMENT

All Il76 are equiped for use of chaff/flare dispensers. Military transports have a tail position for two 23mm guns, though these are not always fitted. Maximum payload is 40,000 kg (88,183 lb).

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### TECHNICAL SPECIFICATIONS

*Dimensions*

| | |
|---|---|
| Wingspan | 50.5m (165 ft 8 in) |
| Length | 46.59m (152 ft 10.5 in) |
| Height | 14.76m (48 ft 5 in |

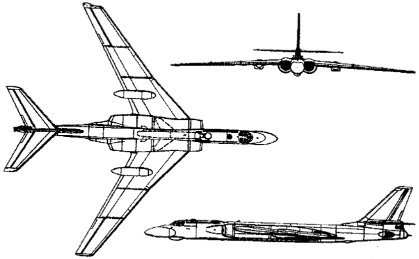
| | **IL76/78** |
|---|---|
| Max speed | Mach 0.68<br>459 kts<br>850 kmh/528 mph |
| Cruising speed | Mach 0.64<br>432 kts<br>800 kmh/497 mph |
| Cruising speed Il78 | Mach 0.6<br>405 kts<br>750 kmh/466 mph |
| Service ceiling | 14,500m/47,570 ft |
| Required runway length | 3,617 n miles<br>2790 ft |
| Maximum range with internal fuel | 6,700 km<br>4,163 miles |
| Maximum range fully with internal fuel | 1,970 n miles loaded<br>3,650 km<br>2,265 miles |
| Maximum range with drop tanks | Not equipped |

Equipment for inflight refuelling is fitted.

Performance Table

# RUSSIAN SUPPORT AIRCRAFT

## TUPOLEV TU16



When the Tupolev 16 entered service in 1954 it was quite a remarkable aircraft, being built from a new lightweight aluminium alloy, and having a considerable range made possible by the newly designed Mikulin AM3 turbo jet.

Originally the main bomb load was to be one huge 9000 kg (19841 lb) freefall bomb, or a large number of small freefall bombs.

Over the years the TU16 has been developed into a myriad of versions to carry enormous early cruise missiles such as the now outdated KS1 (AS1 Kennel). Anti ship versions carried torpedoes or mines, and early in its career the Soviet airforce developed the unusual technique of wingtip to wingtip inflight refuelling with a hose trailed by one TU16 to refuel another.

Of the original 2000 aircraft built 700 remain in service, providing over the horizon, mid-course guidance for Russian Navy anti-ship cruise missiles. Other versions carry the K26 (AS6 Kingfish) anti-ship missile, or have been converted into refuelling tankers, and electronic surveillance aircraft.

### ARMAMENT

One 23 mm gun in the nose, twin 23 mm turrets in the tail, ventral, and dorsal positions. The TU16 has one large ventral weapons bay for stand off missiles, freefall bombs with nuclear or conventional warheads. Naval versions are equipped to carry long range anti ship missiles, freefall bombs, torpedoes, and mines. Maximum weapons payload is 9000 kg (19800 lb).

---

### TECHNICAL SPECIFICATIONS

*Dimensions*

| | |
|---|---|
| Wingspan | 32.99m (108 ft 3 in) |
| Length | 34.8m (114 ft 2 in) |
| Height | 10.36m (34 ft) |

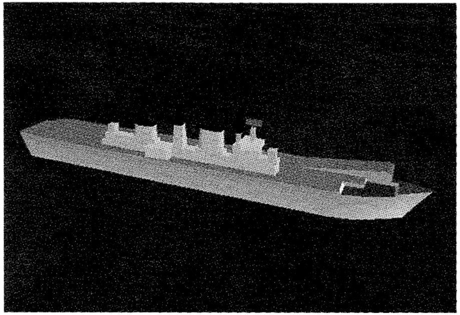
| | **TU16** |
|---|---|
| Max level speed | 567 knots<br>1050 kmh<br>652 mph |
| Service ceiling | 15000m<br>49200 ft |
| Required runway length | NA |
| Maximum range with internal fuel | 3198 n miles<br>5925 km<br>3682 miles |
| Maximum range with drop tanks | not equipped to carry external fuel tanks |

Equipment for inflight refuelling is fitted

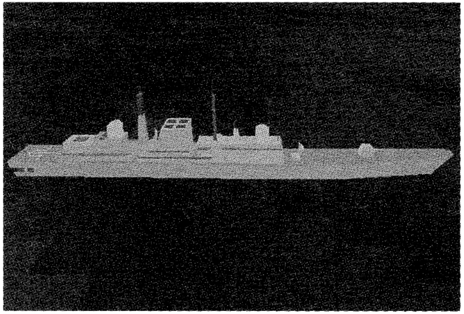
Performance Table

# SHIPS

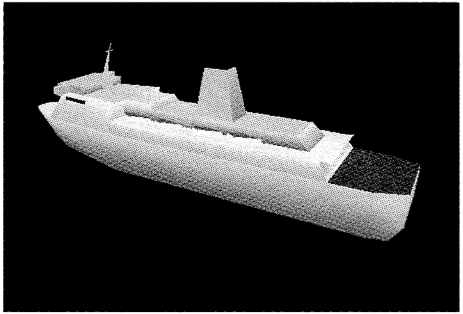
## NATO FLEET



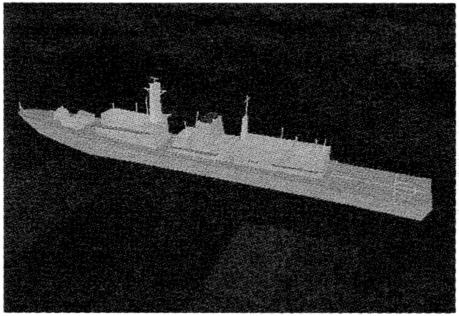
Invincible class carrier



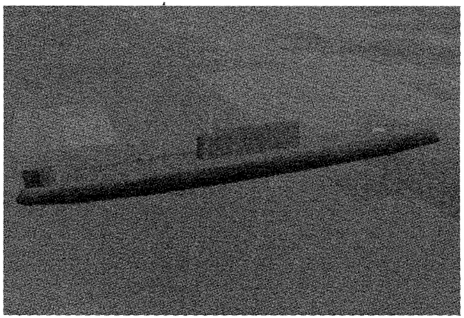
Type 42 destroyer



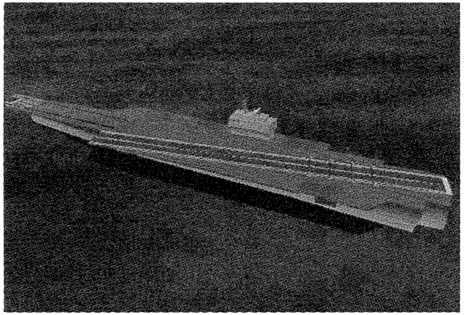
Hospital ship



Type 23 destroyer



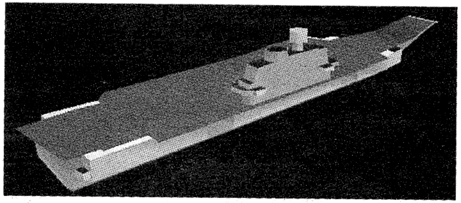
Vanguard submarine

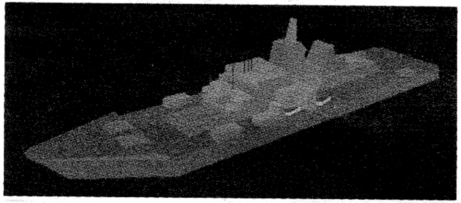


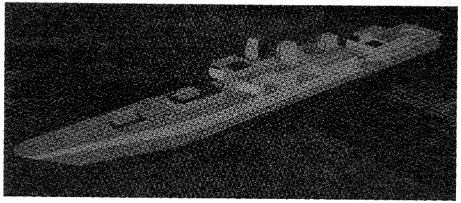
Nimitz aircraft carrier

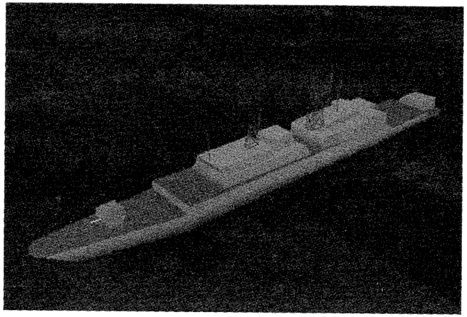
# SHIPS

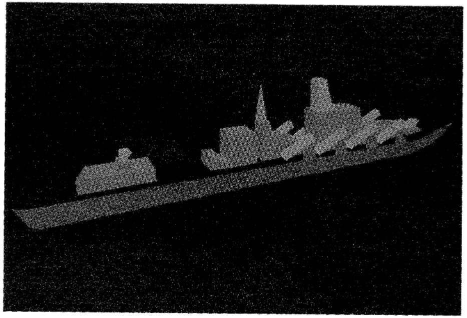
## RUSSIAN FLEET

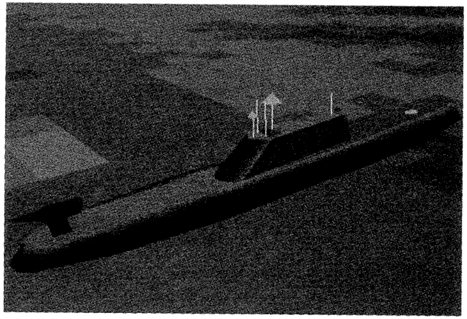

Kuznetsov class carrier

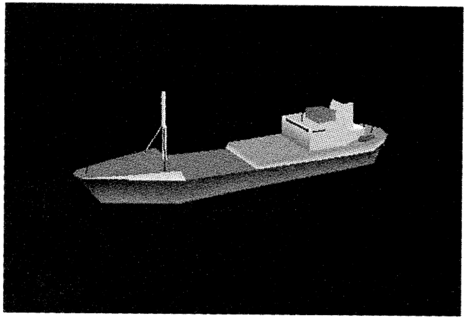

Kirov class battle cruiser


Udaloy class destroyer

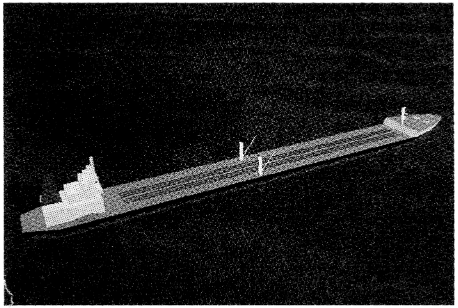

Neustrashimy class frigate


Slava class cruiser

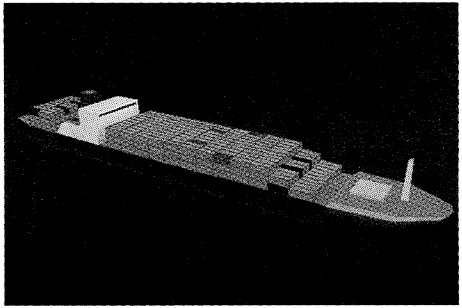

Akula class submarine


Spy trawler

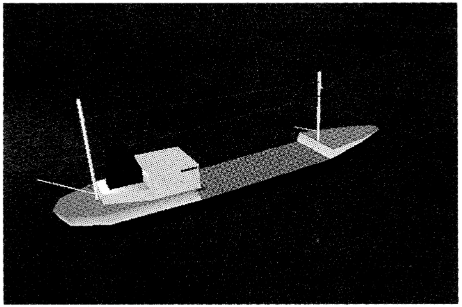
## MERCHANT FLEET



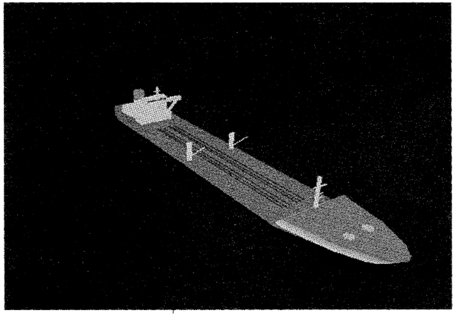
Large oil tanker



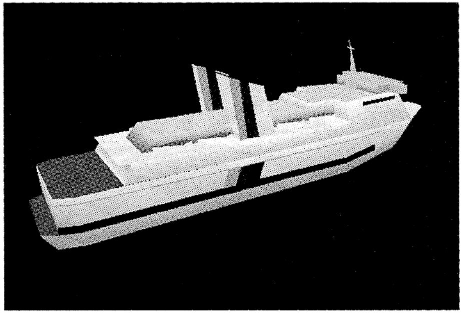
Container ship



Trawler



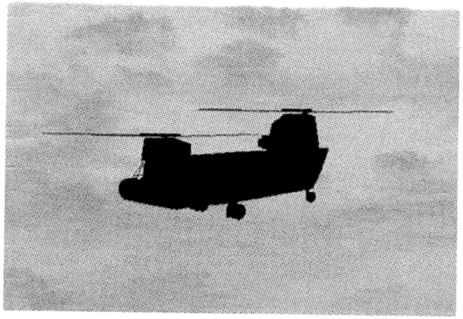
Small oil tanker



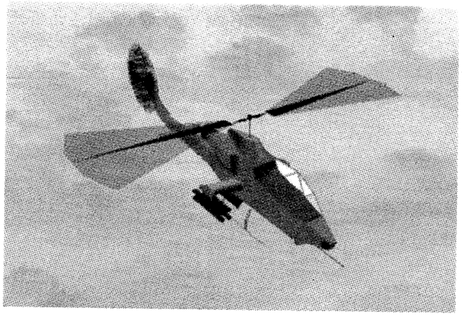
Vehicle ferry

# HELICOPTERS

## NATO

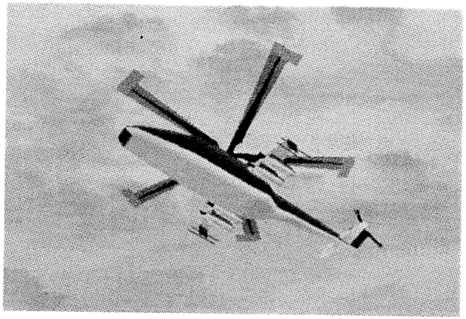


Boeing Chinook CH-47

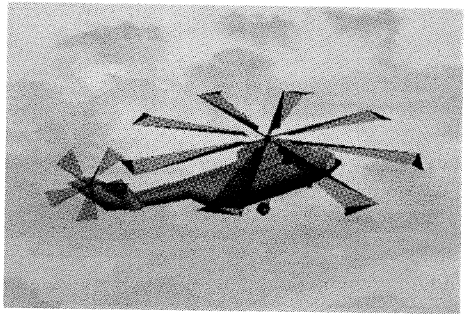


Bell Cobra AH-1

## RUSSIAN



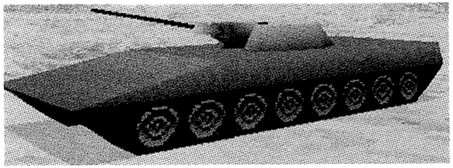
MiL Mi-24 'Hind'



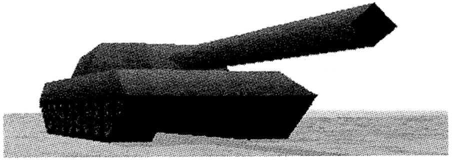
MiL Mi-26 'Halo'

# ARMOURED FIGHTING VEHICLES

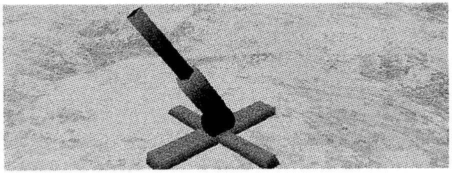
## RUSSIAN FIGHTING VEHICLES



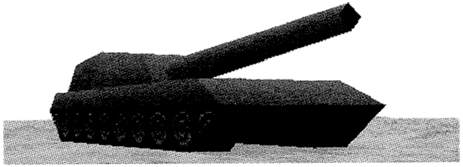
**BMP 1. Role: Infantry Combat Vehicle.**
Armament: 1x73mm MG CO-AX, Sagger ATGW launcher.



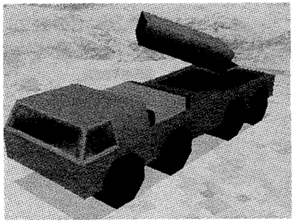
**T80 MBT. Role: Main Battle Tank.**
Armament: 1x125mm Gun/Missile launcher, 1x7.62mm MG CO-AX, 1x12.7mm MG.



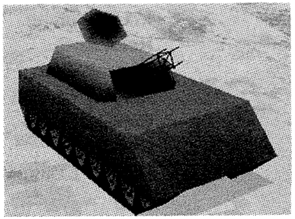
**D30. Role: Towed Field Gun.**
Armament: 1x122mm. Range: 21.9km.



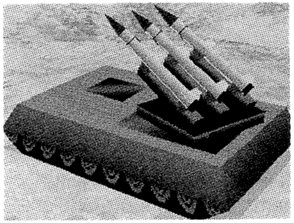
**M1973 (2S3). Role: Self-Propelled Gun.**
Armament: 1x152.4mm Howitzer, 1x7.62mm MG. Range:24km.



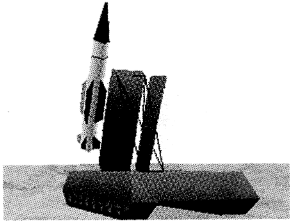
**BM-21. Role: Multiple Rocket System**
Armament: 40x122mm Rockets.
Range: 20.4km.



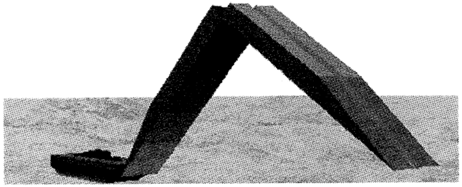
**ZSU-23-4. Role: Anti-Aircraft Gun**
Armament: 4x23mm Cannon.
Range: Approx 5km.



**SA-6. Role: Surface-to -Air Missile.**
Armament: 3xSA-6 SAM.
Range: 24km.



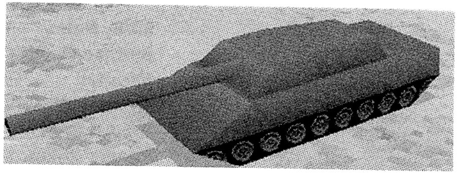
**SA-11. Role: Surface-to-Air Missile.**
Armament: 1xSA-11SAM.
Range: Approx. 100km.



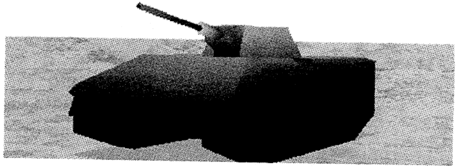
**MTU-20 (T55). Role: Armoured Bridgelayer.**
Armament: Nil.

# ARMOURED FIGHTING VEHICLES

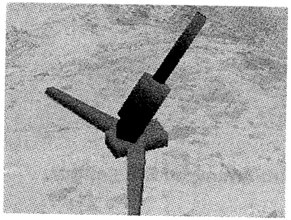
## NATO FIGHTING VEHICLES



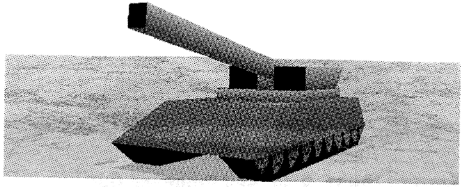
**Challenger 2 MBT. Role: Main Battle Tank.** Armament: 1x120mm, 1x7.62mm CO-AX Chain-gun 1x7.62mm MG.



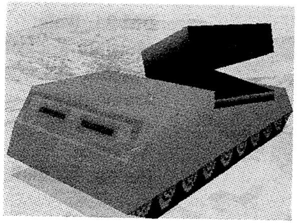
**Warrior IFV. Role: Infantry Fighting Vehicle.** Armament: 1x30mm, 1x7.62mm CO-AX Chain-gun.



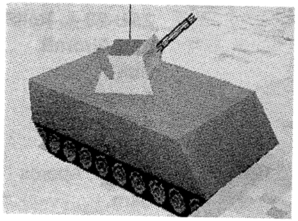
**M198. Role: Towed Field Gun**
Armament: 1x155mm.
Range: 30km.



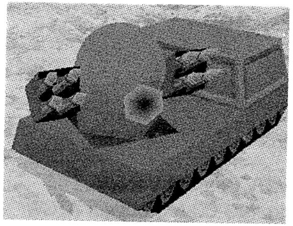
**M110A. Role: Self Propelled Gun.** Armament: 1x203mm Howitzer. Range: 21.3km.



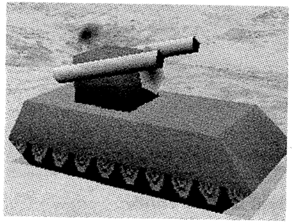
**MLRS. Role: Multiple Rocket System.**
Armament: 12x227mm Rockets.
Range: 45km.



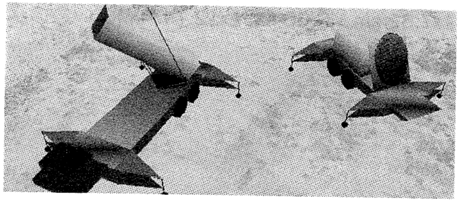
**M163 Vulcan. Role: Anti-Aircraft Gun.**
Armament: 1x6 Barrel 20mm Cannon.
Range: 1.6km.



**Rapier SAM. Role: Surface-to-Air Missile.**
Armament: 8x133mm SAM
Range: 3.6km.



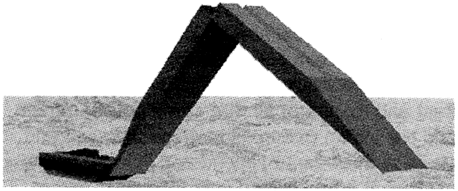
**Roland Euromissile SAM. Role: Surface-to-Air Missile.**
Armament: 2xSAM.
Range: 6.3km.



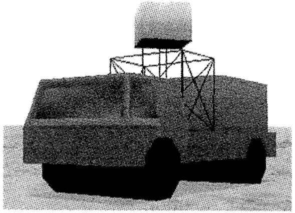
**Patriot SAM & Radar Unit Truck. Role: Surface-to-Air Missile System.** Armament: 4x406mm SAMs per launcher unit. Range: 68.5km.

# ARMOURED FIGHTING VEHICLES

## NATO FIGHTING VEHICLES



**Chieftain AVLB No 8. Role: Armoured Bridgelayer.** Armament: 2x7.62mm MG.



**S373 Truck & Mobil Radar Unit. Role: Radar Tracking.** Armament: Nil.

# EF2000 CAMPAIGN

## PRELUDE TO WAR

It was a tragic parallel: the time that Zrynaski Leader of the Russian Ultra Nationalist Party swept to power in the Autumn of 2001 and history began to repeat itself. A great world power had fallen and was set to rise again, as Nazi Germany had in the thirties.

After the dissolution of the USSR, Russia was plunged into an economic crisis that surpassed the great depression of the thirties. Old trade agreements with the former Satellites broke down and high level corruption and chaos in the Government lead to drastic economic reforms. At the same time, territorial arguments erupted across the former Soviet lands, leading to the loss of confidence and dispute with the Western nations. In turn this caused investment in Russia to collapse, sending inflation soaring by thousands of percent.

Boris Yeltsin, the former Soviet Leader, fought hard to keep the nation together, but a menacing opposition was fast growing - a dangerous mix of Communists and the extreme Nationalists of the Communist National movement, who sought to safeguard Russia's military and economic status. The Communist Party of the Russian Federation, although no longer politically influential, grew to tens of millions. Yeltsin tried to ban them but failed. Eventually, the National Salvation Front, another Communist group banned by Yeltsin, became all-powerful.

By 2000, leaders of the Ultra-Nationalist movement were basking in the majority support of a demoralised populous. Another brief Civil War erupted in Russia for the second time in 10 years. Forces loyal to Yeltsin fled to the former Satellite states of the Ukraine and Belarus. Western leaders showed open support of the Yeltsin Regime, widening the rift between the Western powers and the new Russian Empire of Zrynaski. In Russia, the downward spiral continued with the desperate act of a desperate man...

While the Ultra Nationalist's fought to preserve what was left of the Russian Empire, Western powers plotted to bring it to its knees once and for all. Russia feared them no more. It was time for a New World Order.

The powerful, reborn Russian war machine developed a radical new policy to carry out its threats to reclaim and unite the former CIS nations, to conquer the oil fields of the Middle East and to control all that stood between them and the Indian Ocean. First came the swift and decisive moves into Finland and Poland, taking back what it had owned over fifty years earlier.

Compared with the previous ten years, NATO was just a shadow of its former self. The collapse of Communism seduced Western leaders into massive reductions in the armed forces, although the real threat had never gone away. It had merely changed for the worse.

Taking advantage of the NATO situation, knowing that the United Nations would spend months trying to find a diplomatic solution, the Ultra-Nationalists went ahead with their plans to claim territories they believed were theirs.
In manoeuvres strikingly similar to the German invasion of Poland, the Russians swept into Finland, then into Kazerberstan and Aberstan. Meanwhile, Russian Naval forces seized control of the powerful Black Sea Fleet.

# EF2000 CAMPAIGN

## PRELUDE TO WAR

NATO was paralysed with fear, although no major incursions were made into West European territory. Poland, Slovakia, the Czech Republic, and all the former Warsaw Pact Nations turned to NATO for help. Belarus and the Ukraine, fearing the worst, agreed to a non-aggression pact with Russia. Next to go were the former Baltic states of Latvia, Estonia and Lithuania. Central Europe and the Polish borders were the stage for a massive stand off between the bulk of the Russian War Machine and a NATO force allied with many former Warsaw Pact nations.

With NATO occupied in central Europe, the Russians and their numerically superior airforces could make a daring sweep south from Finland and Norway, cutting off Iceland and gaining control of the sea lanes from America to Europe. If NATO reacted by moving forces from central Europe, they would weaken their defences. This would allow the Russians to punch a hole through Poland and former Eastern Germany, through the Fielder gap and through the rest of Germany, bringing NATO to its knees. Of course, both sides still held the Nuclear card.

Central Europe became a buffer zone, NATO depending on the huge expanses between Poland and its Eastern flanks. Even with the Atlantic under Russian blockade, Europe could hold out for weeks against a Russian onslaught. This would give time for NATO to reinstate the original logistics plans of the Cold War period. Russian leaders knew that well-supplied NATO forces in Germany would be almost impossible to defeat. They had to take the North and gain control of the Atlantic, and with most of NATO's forces committed in central Europe, it should be just a matter of time.

The future of Central Europe would be decided by the battle of Norway - a battle that was to be fought principally in the air and at sea. The unforgiving topography of the Scandinavian and North Cape areas is unsuitable for ground warfare. Unfortunately for the West, the almost constant daylight of the Nordic summer months rendered squadrons of NATO Stealth Fighters all but useless. An air battle between high-tech super-powers was about to begin, the likes of which had not been seen since the Battle of Britain. For the Russians, capture of intact Norwegian airbases was the primary objective.

### THE STATE OF WAR

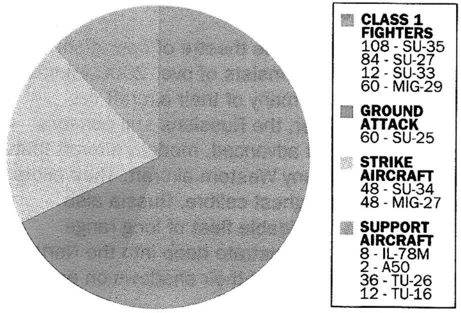
In the Northern Europe theatre of operation, the Russian air army consists of over 2000 front line aircraft. Although many of their aircraft are technically inferior, the Russians still possess large numbers of advanced, modern aircraft that are a match for any Western aircraft. Their pilots are also of the highest calibre. Russia also possesses a formidable fleet of long range bombers able to penetrate deep into the North Atlantic region, casting their shadows on each and every sea lane.

Between them stands Norway and eight front line air bases, two US carrier fleets, a UK carrier group and long range support from Denmark, Scotland and Iceland. Several hundred NATO fighters and bombers stand against a force twice their size.

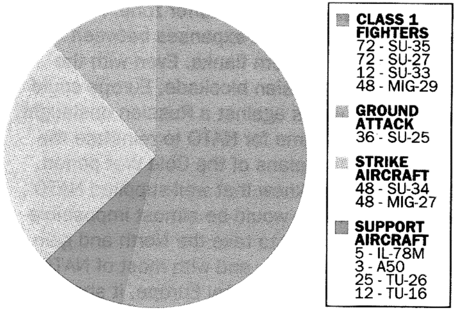
***In all, the total number of EuroFighters deployed in Norway is 356 with over 240 in reserve in Scotland.***

# EF2000 CAMPAIGN

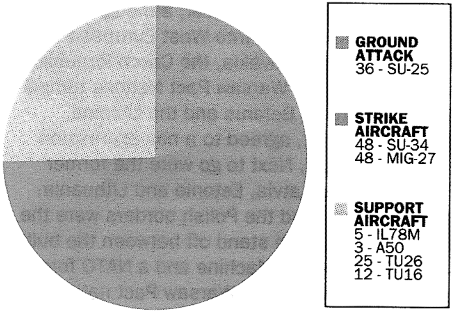
## PRELUDE TO WAR



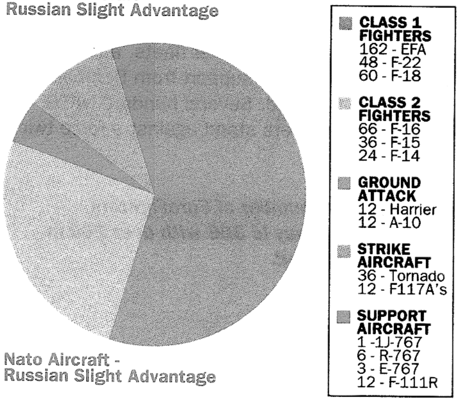
Russian Aircraft -
Russian Slight Advantage



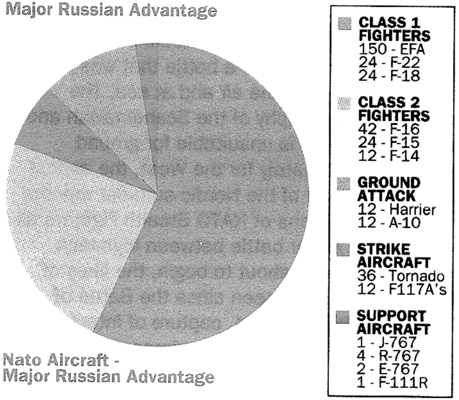
Russian Aircraft -
Major Russian Advantage



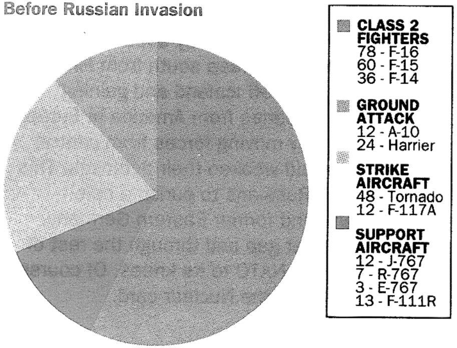
Russian Aircraft -
Before Russian Invasion



Nato Aircraft -
Russian Slight Advantage

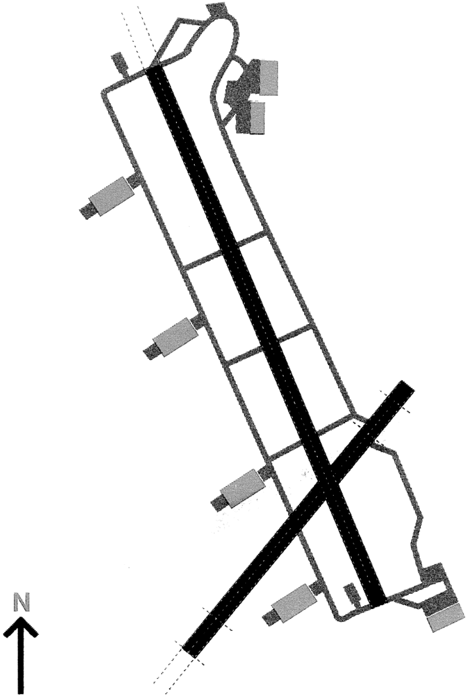


Nato Aircraft -
Major Russian Advantage



Nato Aircraft -
Before Russian Invasion

## ANDOYA



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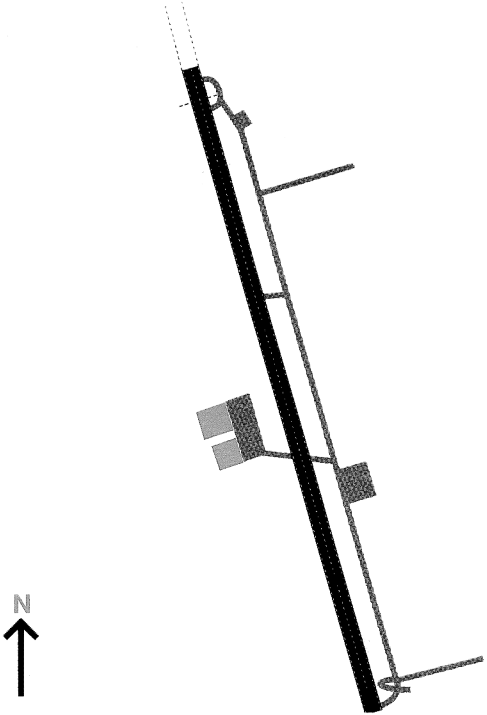

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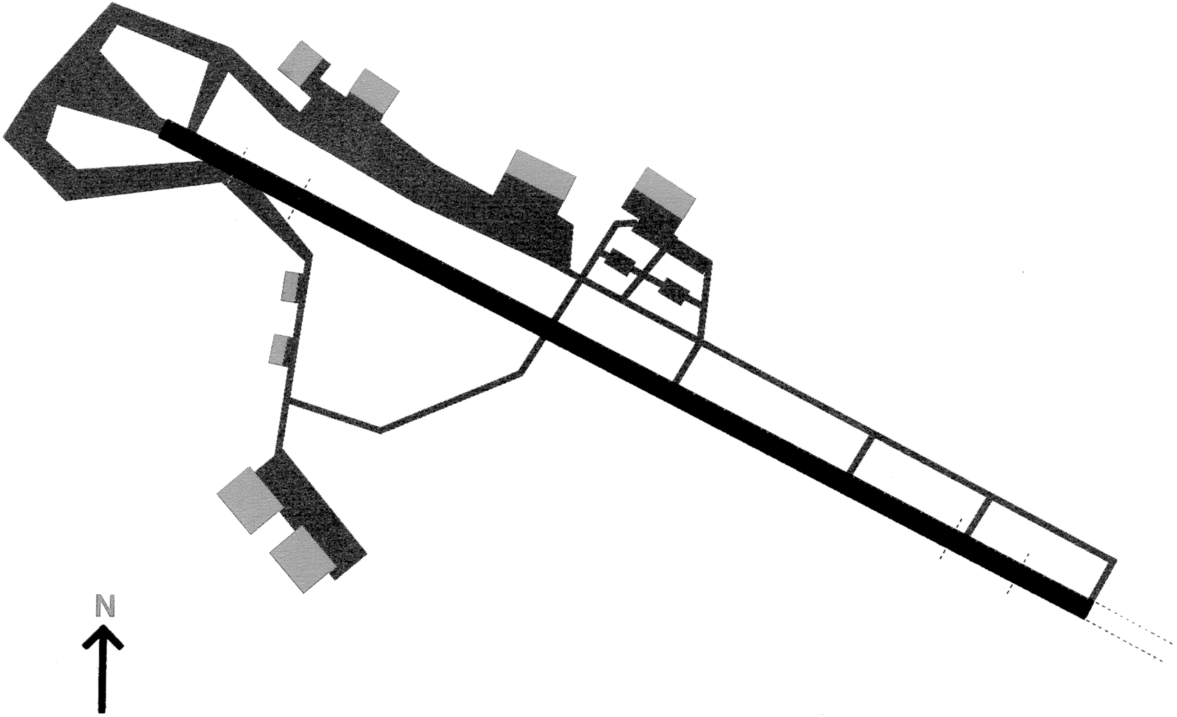

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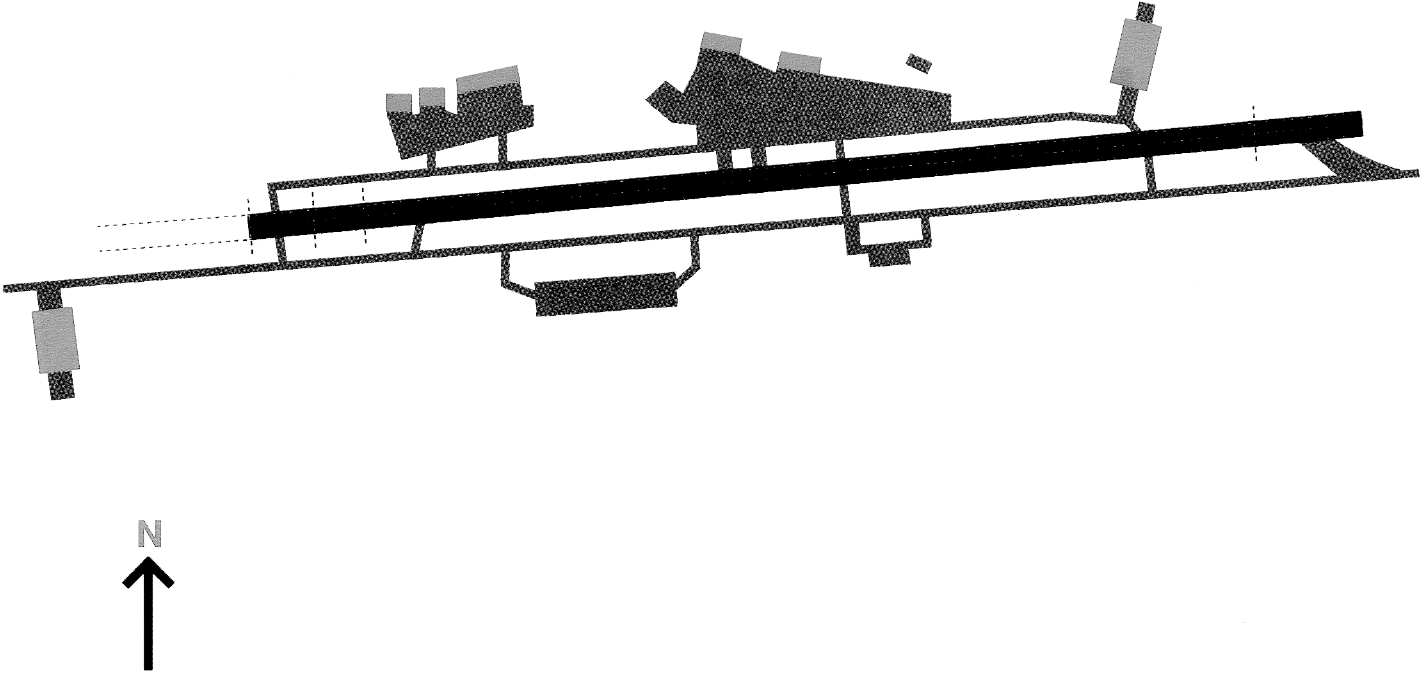
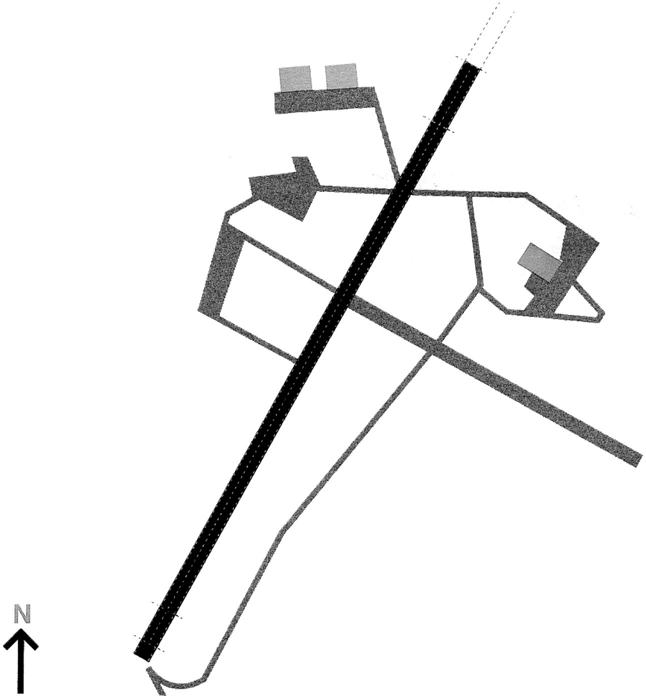
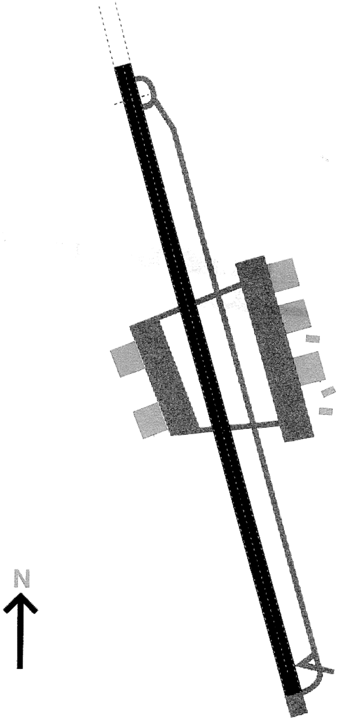


# MILITARY AIRFIELDS

## OSLO

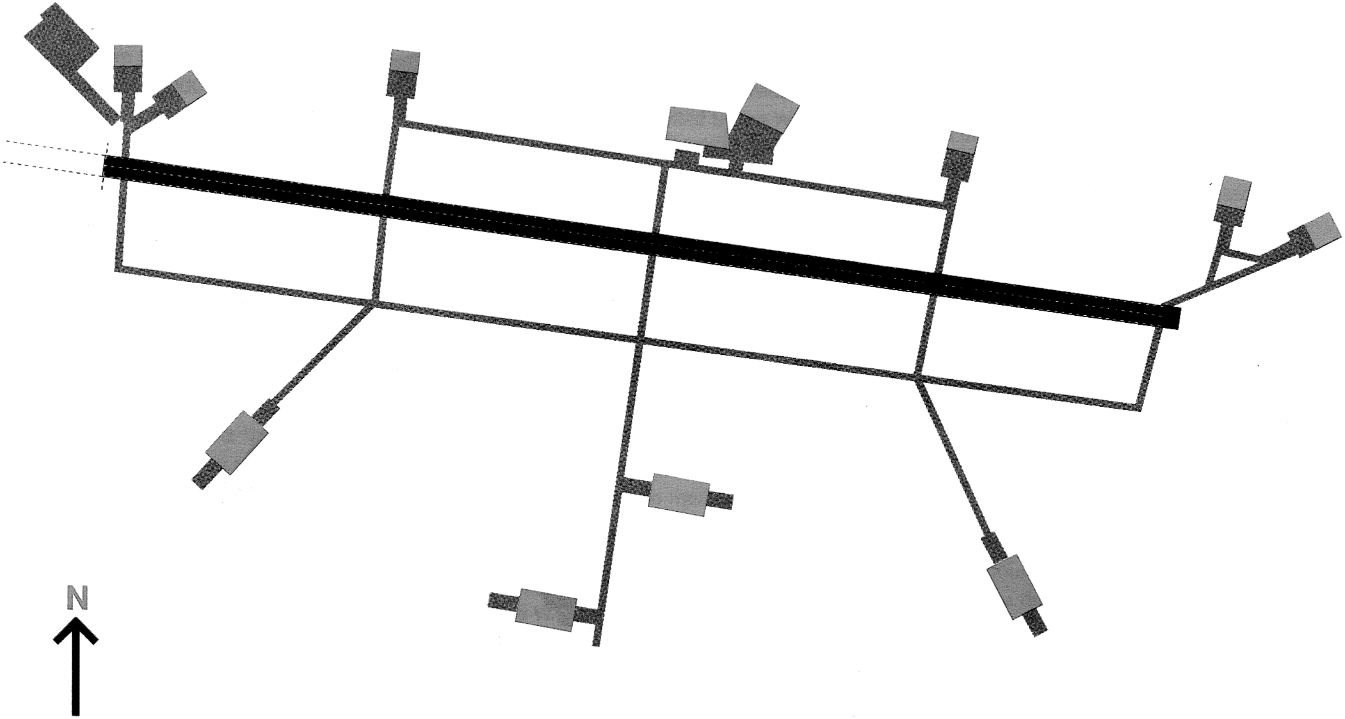


## PROVINCIAL AIRFIELD



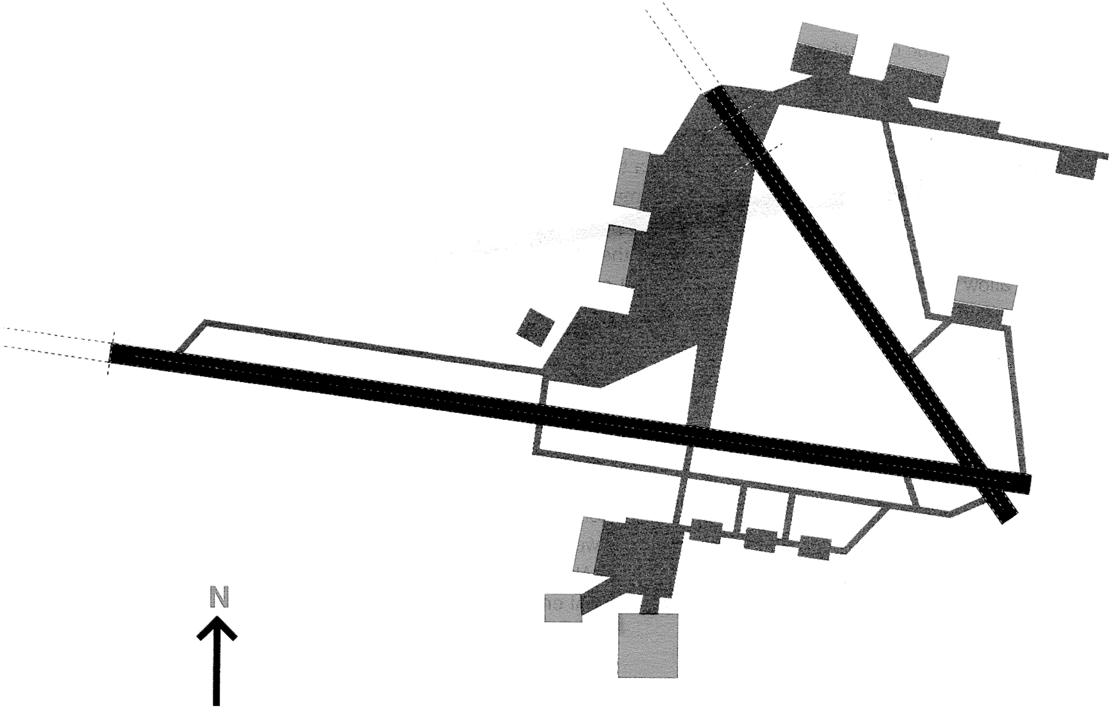
# MILITARY AIRFIELDS

## RYGGE



# MILITARY AIRFIELDS

## TRONDHEIM



# THE WARGEN SYSTEM™

## HOW THE CONFLICTS ARE DRIVEN

The DID War Generator, or WARGEN system, was born from the desire to create a realistic combat environment for the EF2000 simulation. After all, a good flight simulation has to do far more than just mimic real aircraft. Many war simulations suffer from the tedium associated with managing the massive amounts of data used to model a large scale conflict. The aim of the DID War Generator was to fully automate the management of this data to allow the users to concentrate entirely on their role as a pilot.

To produce an AI system capable of controlling all aspects of a future war, from the organisation and movements of carrier fleets to the repair of runways and hangars, required a great deal of research. An AI system was designed that would mimic the hierarchical command and control structure of modern Air and Sea forces. The system was tailored towards a Norwegian Limited Theatre Conflict where the emphasis would lie with Sea and Air power (the Norwegian terrain would make a land war difficult).

The DID WARGEN is actually a sophisticated war-gaming engine that underlies the unique 3D world of EF2000. Over 10,000 individual objects in the 3D world are controlled by the WARGEN as you interact with the environment. This is what makes EF2000 a true hybrid of wargaming genres. If the demand is there, we may soon decide to give the player the power to manipulate the AI that drives the WARGEN, enabling you to set-up and play-out scenarios in a way that will astonish military strategists. Let us know what you think!

Some of the theoretical basis for WARGEN came from the ideas presented in Colonel A. Warden's book on the operational theory of a modern airforce. His ideas on the mechanics of the airforce and its relation to the other sectors of the military machine were integrated with the original design of the AI engine to produce the core of the WARGENs AI engine.

### TOTAL WAR GAMES

The WARGEN operates at four distinct levels of command based AI. Data in the forms of orders and directives are filtered down through the system to the lowest levels. Field reports and statistical data are then propagated back through the system to update the higher levels of intelligence allowing the WARGEN to accurately manage the overall conflict.

The highest of these levels is The Grand Strategic Level. This level manages the forces from a governmental or military chiefs perspective and is responsible for the overall direction of the war as well as the maintaining of international relations with all other protagonists. It is at this level that a protagonist may decide to surrender, or indeed may decide to bring a neutral country into the conflict by force in order to improve their current situation.

Below this lies the Strategic level AI that is responsible for organising the forces available in terms of material (all military hardware),

## HOW THE CONFLICTS ARE DRIVEN

personnel (pilots and other highly trained military persons) and position (relocating forces to maintain good defensive/offensive locations), to try to meet the demands made at the Grand Strategic level. In addition to this, the Strategic level also maintains force strength and mobility by calling for reserves and additional force where needed. In general this level deals with logistics.

The Operational Command level is by far the most complex. It is responsible for the generation of all Land, Sea and Air missions for all protagonists. Missions are generated to very high levels of detail to ensure an accurate model of the conflict is created. Sea forces are used to resupply the land and air forces, and the carrier fleets are positioned to complement the forward line bases and provide a strong defensive/offensive position. Land forces are used to transport supply from the coast to the bases inland. The limited ground war means that the positioning of the land forces is crucial to the defence of forward line airbases, supply dumps and command centres. Air missions are generated both to provide defensive air cover and offensive strikes into enemy territory.

The lowest level in the WARGEN hierarchy is the Tactical Combat level. At this level sophisticated combat rules are used to resolve all land, sea and air combat. Detailed battlefield statistics are generated at this level for examination by higher levels of the system.

Using these four hierarchical levels of AI, WARGEN can manage an entire theatre air campaign. In practice WARGEN manages an area of over 4000,000 square km and controls the operations of over 1000 planes, 2000 ground units, and 500 ships. Of course, you will be just a small cog in a large machine, but as you are flying NATO's most effective air weapon, you are able to make a significant difference to NATO's fortunes in the campaign.

### THE IMPORTANCE OF ACCURACY

Great care has been taken in developing the AI routines with the data, statistics and probability tables to ensure that the data used by the system is as accurate to real-life as possible.

### GRAND STRATEGIC LEVEL

At this level you will receive signals when an allegiance (protagonist) is defeated or surrenders. The AI continually monitors international relations, which affect actions such as the response of fighters and SAMs in neutral countries; e.g. a fighter from a neutral country is shot down by your flight - the next time you go into this neutral airspace you will be actively tracked down and destroyed without mercy.

In addition, keeping on good terms with non-combatant countries means that you can use their road/rail network and ports to bring in your supplies. If they become angry with you, they will not allow you to use their transport network, thereby cutting your supply network and making life easier for the enemy!

# THE WARGEN SYSTEM™

## HOW THE CONFLICTS ARE DRIVEN

### STRATEGIC LEVEL

Once your friends and enemies are identified it is then necessary to re-distribute your forces to defend your territory, or put yourself in optimal attacking positions (if attacking is the correct response). The strategic level performs all necessary force distribution and resets the primary supply routes. If force sizes are getting dangerously low then reserves will be brought in.

### OPERATIONAL LEVEL

This is where it all happens. Your aim is to select the most important enemy targets for your overall campaign. Then for each base these targets are prioritised. The operational level will build a mission for all prioritised targets and decide who is going to do what to whom, where and when.

For the planes: the AI selects the most appropriate plane for this type of mission from a desirability list; then it selects the appropriate size and content of the mission in terms of flights and number of planes; and finally, it selects the supply requirement for the mission.

For the airbase: the AI assesses the ability of the airbase to cope with this mission given the amount of air traffic already going through the base. An ATC system is used to schedule the launch of all missions.

For the target type: the AI selects exactly the correct weapon package for the target type from over 500 possible combinations

For the waypoints: the AI plots waypoints to and from the target making use of the terrain or using safe (out-to-sea) routes, or routes through neutral countries.

JSTARS and AWACS are positioned to achieve maximum detection range whilst still being in secure friendly airspace, usually only a short sprint away from a base. Refuellers are positioned for maximum accessibility but away from direct enemy threat - although refuellers near to the FEBA will be at considerable risk.

CAP routes are chosen based on information about previous enemy incursions and local topography. Strike routes are chosen to try and get the strike flights to target as safely as possible. From the ingress point onwards, each pilot on a flight is made to follow an individual waypoint route called an attack pattern - each tailored to the weapon type and target type which ensures that the planes release their weapons over the target at the correct time intervals. All this is done not only for the EF2000 but all of the 1000 plus planes in the world.

# THE WARGEN SYSTEM™

## HOW THE CONFLICTS ARE DRIVEN

### SELECTION OF GROUND FORCES AND PLACEMENT OF AIR DEFENSES.

For Ground based vehicles the most appropriate trucks and tanks are selected for offensive or supply missions. The choice of the safest supply routes to use that day will allow the required amount of supply through.

Placement for all 500 plus SAM sites, and 100 plus AAA guns is also calculated.

Placement of battle vehicles in the currently disputed areas of the world is carried out as follows. . .

For Ships: placement of the carrier fleet adjacent to the current area of most offensive operations. Selection of the safest supply routes to use to get ships either to or from ports for supply. Attack-ships are positioned when an attempt is made to capture a base.

### BASE REPAIR AND CRITICAL TARGETS

When critical targets such as runways and control towers are damaged the AI system will begin a series of simulated repairs over the course of several hours or days. Some targets such as a heavily damaged control centre can take days to repair if it is possible at all; others such as runways can be mended in under six hours if the damage is not too severe.

### THE PILOTS

All pilots are individually modelled; i.e. many pilots all have several attributes describing their behavioural characteristics, skill and experience. After each mission, a pilot is reassessed and his details are updated for the next phase of missions.

### TACTICAL LEVEL

When you actually fly your mission, an advanced tactical AI system processes all ground and air combat that occurs around you. All AA combat in which you are directly involved is handled by the SmartPilots system. All combat more than 100 miles away from the player is dealt with by the WarGen system. The results are plane based and takes into account the ability of each plane to: achieve a lock-on the enemy; the probability of missile hitting if launched, based on military data; the plane combat performance ratings; and the relative plane proximities.

All AG combat is processed in a similar way. The AAA combat uses probabilities of a lock-on coupled with the plane's ability to evade the lock, and a probability of kill to determine the outcome.

# THE SMARTPILOTS SYSTEM™

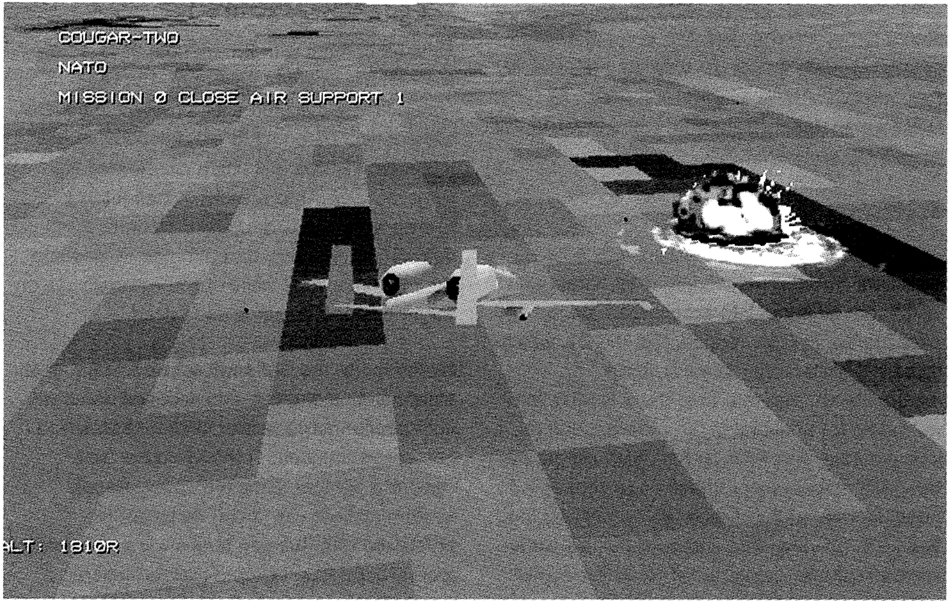
## YOUR COMPANIONS IN THE SKY

For the first time ever, a DID simulation features the SmartPilots Artificial Intelligence System. The system combines real-time aerodynamic modelling with behaviour dictated by modern military doctrine to provide an all-round simulation, not only of the aeroplane you are flying, but of the entire battlefield environment. SmartPilots compliments WarGen as an in-game AI system.

### DETAILED MISSIONS

As you fly a mission in EF2000, you will follow a waypoint route, stopping to engage the enemy, to refuel, or perform other mission-critical tasks. The computer-controlled planes (CCPs) which you will encounter as an EF2000 pilot all have their own missions just like yours. Some, like CAP, are missions which you can fly yourself. Others, like AWACS, are only available to certain aircraft types.

Each CCP flight is commanded by a wing leader, who will follow his waypoints, and decide what actions the flight should take, responding to the



An A-10 attacks a tank under SmartPilots control situation in hand. Just as you will sometimes be contacted by AWACS, JSTARS, or another flight in your mission, so will the CCP wing leaders. In fact, if a CCP CAP is in a better position to intercept an enemy flight than yours, AWACS will send them instead of you.

### AERODYNAMIC MODELS

In flight, CCP motion is determined by a full aerodynamic flight model. Lift, drag, thrust and weight are all taken into account, as are roll and pitch inertia. For this reason, the MiG-21, which lacks a G-limiter, can obtain a higher instantaneous turn rate than the 9 G F-16, but will lose a lot of speed in the process, due to induced drag. The A-10, with its high aspect ratio wing, will maintain an excellent turn rate at low speeds, where either fighter will bleed off speed. The F-15, although fast and powerful, will suffer in close combat against a fighter with a higher roll rate, like the SU-27.

### THE DOGFIGHT ALGORITHM

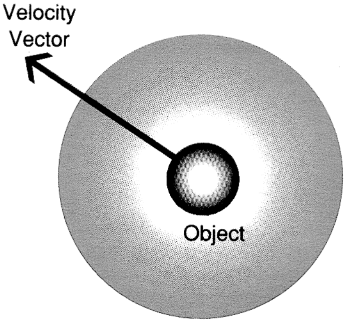
Air-to-air combat with SmartPilots uses a new system, the Dogfight Algorithm. The CCP continually re-calculates its situation in combat, without ever resorting to set manoeuvres. For instance, instead of using a pre-defined high yo-yo manoeuvre to prevent overshoot in a turning fight, the CCPs will incorporate a calculation of energy and turn-rate tactics into their manoeuvring, while still keeping an eye on target position, heading and speed.

Furthermore, the CCPs will act as a team, each flight splitting into two-ship sections which will co-ordinate their attacks using modern air-combat techniques. You may notice the opposing fighters using the double-attack system against you. It can no longer be presumed that Russian forces will use out-dated ground-control tactics and trail formations.

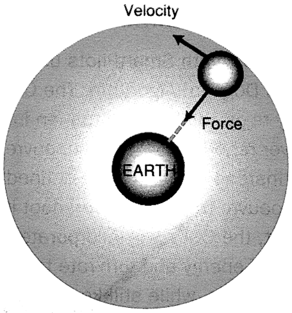
# THE FLIGHT MODEL

## DYNAMICS

Imagine an object moving in space. It moves in a certain direction at a certain speed. These can be described by its velocity vector. The size of the velocity vector represents the speed, and it points in the direction of motion.



According to Isaac Newton,  this object will keep on moving with the same velocity until a force acts on it. A force in the same direction as the force at right angles to the velocity will not change the speed, but will alter the direction of the object's motion towards the direction of the force. In this way, a satellite moving around the Earth will always be pulled downwards, but will never hit the ground.



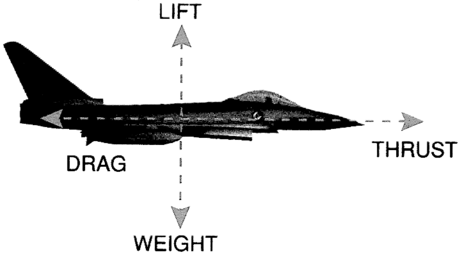
Now imagine our object is not in space, but in the air, about 10,000 feet up. It is being acted on by the force of gravity. Due to its motion through the air, it also encounters air resistance, or drag.

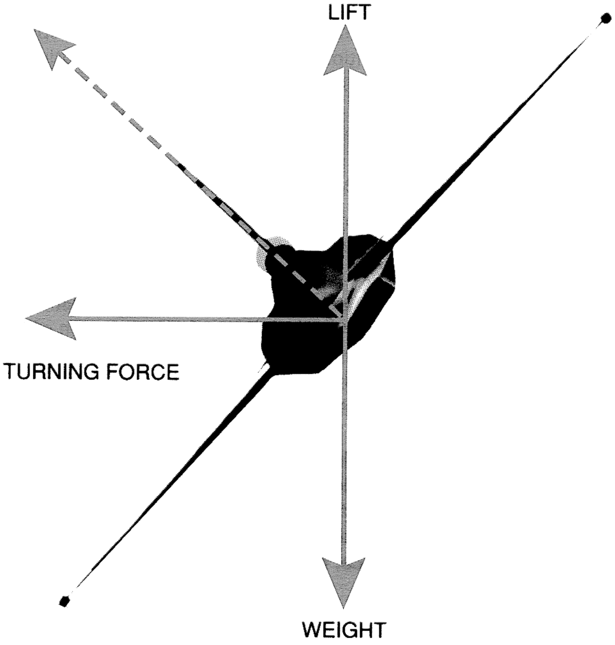
These two forces add together to make the object slow down and fall. If the object is an aeroplane, we can stop this from happening. The engine provides thrust to balance the drag. To counter the effect of gravity, the wings provide lift.

# THE FLIGHT MODEL

## DYNAMICS

As with the satellite, only a force at right angles to the plane's velocity can turn it around. Viewed from behind, the aeroplane makes a level turn by banking to one side and increasing lift, so that the vertical part of the lift balances weight. Then the horizontal part of the lift is not balanced out, and so turns the aeroplane.


LIFT
DRAG
THRUST
WEIGHT

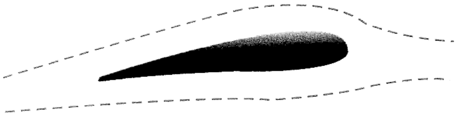

LIFT
TURNING FORCE
WEIGHT

# THE FLIGHT MODEL

## AERODYNAMICS

A wing produces lift by deflecting the air flowing past it downwards, which pushes the wing in the opposite direction. The shape of the wing can produce this effect, as can its angle of attack. The higher the angle of attack, the greater the lift. If angle of attack is too great, the air can no long move round the wing from leading to trailing edge, and the area behind the wing becomes a wake. This is called stalling. A stalled wing produces little lift.

NORMAL FLIGHT

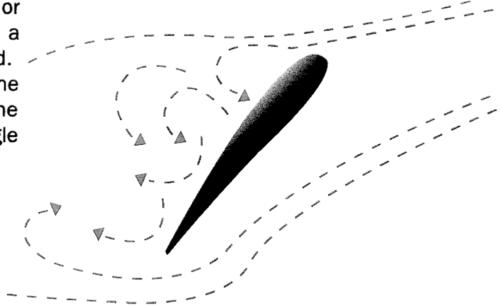


Any object in air flow is pushed back by drag. Lift produces extra drag, which adds to the normal, or profile drag. This means that an aeroplane in a turn needs more thrust to maintain its speed. A conventional aeroplane works by pointing the tailplane down; the lift from the tail rotates the aeroplane nose-up, so the wing has a high angle of attack and produces plenty of lift for turning.

### EF 2000 AERODYNAMICS

The EF 2000 has foreplanes instead of a tailplane. Also called canards, these work by pitching up to rotate the aeroplane. At low speeds, the EF2000 is unstable, so the canards are then deflected down again to balance the aeroplane at the higher angle of attack and prevent it from flipping out. This instability is not noticed by the pilot because between the pilot and the aeroplane is a flight control system (FCS) which makes the necessary control inputs to stabilize the aeroplane.

STALL



Unlike the WWI pilots, who moved control surfaces with mechanical linkages, the EF2000 pilot is shielded from the actual business of pitching the canards and ailerons. The joystick position is interpreted by the FCS as a demand for a certain roll rate and pitch rate. This means that when the stick is left alone, the EF2000 will neither pitch nor roll, even if it is highly banked or upside-down.

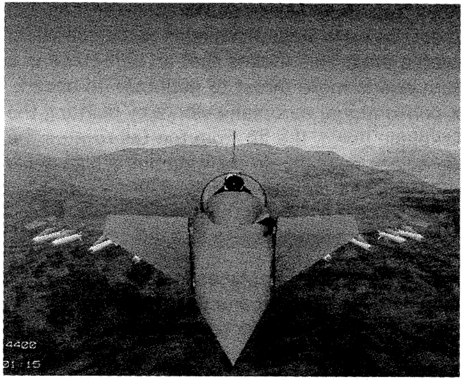
# THE FLIGHT MODEL

## AERODYNAMICS

### THE FLIGHT MODEL

The flight model in EF2000 is a dynamic, six degree-of-freedom model, which simulates the actual aerodynamics of the EF2000 design. It incorporates the instability and coupled behaviour which can be expected in an aeroplane like the EF2000. This means that if you were given direct control of the control surfaces, you would need constantly to adjust the stick just to stop the aeroplane from flipping up or down, or from side to side. So EF2000 also includes a flight control system which shields the player from most of these complexities, just as the real EF2000 does.

As an example, Select the simulator option from the EF2000 menu and choose free flight. Use TimeSkip to set your aeroplane on the runway. Now turn on first your wheelbrakes, then your afterburners. The aeroplane will not move forwards, but will pitch down a little. This is because the brake friction on the wheels counters the engine force, but as it acts below the centre of mass, this pitches the aeroplane down.



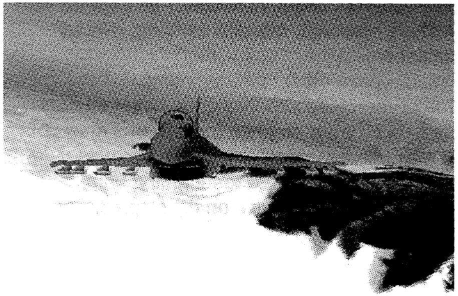
**Front view of EF2000 in subsonic turn**

Now select an outside view of your aeroplane and release your wheelbrakes. As you accelerate along the runway, notice the way the canards pitch up and down. This is because the flight control system senses the oscillation of the aeroplane, and is trying to damp out this motion. At around 120 knots, pull back on the stick to take off. Retract your undercarriage and release the stick.

Now pause the simulator and select the front camera view. Unpause and pull back hard on the stick, holding it in this position. Notice the canards pitch up initially, then pitch downwards. Due to the EF2000's instability at subsonic speeds, it needs to pitch the canards down just to maintain this pitch rate without turning even faster. Keep the aeroplane pitching until the nose is level again. Now release the stick. Note the slight pitch-down on the canards to return to steady flight.

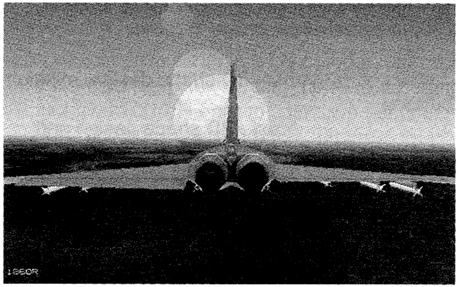
# THE FLIGHT MODEL

## AERODYNAMICS



EF2000 in supersonic turn

Return to level flight and select a rear view of your aeroplane, then apply some rudder. As the rudder moves, notice also that there is some motion of the flaperons (the combined flaps and ailerons on the wing trailing edge). This is because the rudder, as well as yawing the aeroplane (turning it sideways) will tend to cause roll as well. To counteract this, the FCS applies some aileron deflection automatically. This is a feature which is not in the development EF2000 aeroplanes, but which is expected to be implemented in the production models.



EF2000 with rudder applied

# EF2000 CREDITS

## WHO'S WHO

The following is a list of the EF2000 team at DID, in alphabetical order

**Andrew Bate** - Artist - 3D shape design, mission building.
**Andrew Gahan** - Artist - 3D shape design and mission building.
**Chantelle Thacker** - Artist - 3D shape design.
**Charlie Wallace** - Programmer - 3D World code.
**Chris Orton** - Head of R&D - 3D techniques and effects.
**Colin Bell** - Director of Programming - project planning and game integration.
**Craig Houston** - Artist - world building and design of texture maps.
**Damian Edwards** - Mission development, testing and manual proofing.
**Dave Ambler** - Artist - 3D shape design.
**Derek Johnson** - Programmer - in-game language handling for localisation.
**Don Whiteford** - Project Director and Producer - simulation design, project management, manual concept, and manual copy.
**Donna Chippendale** - Artist - rendered 3D-Studio art for the simulation and manual.
Geoff Wynne - QA - game testing.
**Iain McLeod** - R&D Programmer - Network Communications System and GUI system development.
**Ian Boardman** - Head of 3D Design for EF2000 - management of 3D modelling and world building.
**Ian Tasker** - Artist - 3D shape design.
**John Bradley** - Network Manager.
**John Knight** - Researcher - background information on Norway, scenario maps, general research and testing.
**Jon Spencer** - QA- game testing.
**Martin Carter** - Artist - world building and design of texture maps.
**Martin Kenwright** - Managing Director and Producer - original concept, EF2000 creative direction, publisher relations and manual copy.
**Michael Hocking** - R&D AI Researcher - WarGen design and coding, AA combat AI, neural networks, GUI system design and manual copy.
**Mike Burrows** - R&D Programmer - EF2000 research and development.
**Neil Ambler** - Artist - 3D shape design.
**Neil Lecky-Thompson** - Aeronautical Engineer and Programmer - Weapons flight models.
**Nevil Plura** - Lead Programmer Military Systems - TIALD simulator development and adaptation for EF2000.
**Nick Clarkson** - Press & Media Relations Manager - publisher liaison, press and advertising.
**Paul Chaffe** - Military Liaisons - assistance with military research, mission building, military liaisons.
**Paul Frewin** - R&D - programming.
**Paul Hollywood** - 3D Designer - input into 3D systems, target management, missions and environment building.
**Phil Owen** - QA - game testing.
**Ralph Van Doorn** - Mission development and testing.
**Robert Ball** - Artist - texture map design.
**Robin Anderson** - R&D programmer - sound and music integration.
**Rob Openshaw** - QA - game testing.
**Roderick Kennedy** - Head of Aeronautical Engineering and Programmer - Flight models, SmartPilots AI controlled pilot system and manual copy.
**Roger Godfrey** - Programmer - Avionics and AI.
**Russell Payne** - Director - 3D engine design, R&D.
**Shaun Hollywood** - Creative Director - graphic design.
**Simon Kershaw** - Artist - 3D shape design, mission building, manual copy.
**Stephen Powell** - Programmer - WarGen components, avionics and GUI implementation.
**Steve Monks** - Lead Programmer - Avionics, program module integration.

# EF2000 CREDITS

## WHO'S WHO

**Steve Tickle** - R&D programmer - cool explosions.
**Stuart Jennett** - Artist - EF2000 Silicon Graphics art.
**Tim Johnson** - Assistant Producer - mission building, 3D world design and manual copy.
**Tony Buckley** - Head of Testing - quality control and publisher relations.

With thanks to. . .

**the Advertising Agency Ltd** - Advertising, packaging, videos, documentation design and production.
**BAe Publicity Dpt** - Information, advice and support.
**David Chinn** - Royal Aeronautical Society and NEFMA.
**DID Administration** - All the support staff in the office.
**IBM Computers** - Hardware.
**John Turner** - EF2000 Test Pilot.
**Key Publishing** - Information and aircraft line drawings.
**Lockheed Publicity Dpt** - Information.
**Ned Frith** - Head of EF2000 Marketing at British Aerospace.
**Ocean QA** - a big thankyou for all the hard work and late nights.
**Ocean Software** - Our publishers and much more.
**Orinoco Sound Source** - Sound effects and music.
**Pete Birch** - RAF Advisor.
**Polylang Ltd.** - Localisation.
**Robert Lynch** - Military contacts and encouragement
**Squadron 13** - Enthusiasm and advice.
**Squadron Prints** - Supply of special EF2000 prints and postcards.
**Steve McLaughlin** - RAF (retired) Air Defence Consultant.
**ThrustMaster** - Suppliers of flight peripherals.

And anyone else who we may have forgotten to name, but who has contributed directly to the project.

Special thanks to the partners and children of team members, who have suffered as much if not more than the rest of us. We will make it up somehow!

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# BIBLIOGRAPHY

**Air Power** T. Mason, Brassey's Ltd., ISBN 1857530691

**Aviation,** The Story of Flight, B. Gunston, Sundial Ltd., ISBN 0904230562

**Avionic Systems,** D.H. Middleton, Longman Ltd., ISBN 05802018811

**BAe/McDD Harrier,** M. Spick, Salamanda Ltd., ISBN 086101569X

**Beyond the Horizon,** P. Handleman, Airlife Ltd., ISBN 1853103985

**Bridges, D. Brown,** Reed Publications, ISBN 1857321634

**Combat Arms, Modern Fighters,** B. Gunston, Salamanda Ltd.

**Combat Colours,** B. Archer and P.R. Forster, Osprey Ltd., ISBN 1855322056

**Combat Missions from the Cockpit,** K. Delve, Sterling Pubs., ISBN 085840094

**Display Pilot,** R. Lea, Osprey/Reed Ltd., ISBN 1855324458

**Electronic Warfare,** D., Richardson, Salamanda , ISBN 0861012658

**Fighter Combat,** R.L. Shaw, Pat Stephens Ltd., ISBN 0850598427

**Gulf Air War Debrief,** S. Morse, Aerospace Pubs. Ltd., ISBN 187402314X

**High Tech Warfare,** R. Jackson, Headline Ltd., ISBN 0747205094

**High Tech Weapons of the Gulf War,** T. Smart, Salamanda, ISBN 1856130479

**Modern Airborne Missiles,** B. Gunston, Salamanda Ltd., ISBN 0861011600

**Modern Aircraft Markings,** M. Spick and B. Wheeler, Salamanda Ltd., ISBN 0861016955

**Modern Attack Aircraft,** M. Spick and T. Ripley, Salamanda Ltd., ISBN 0831750545

**Modern Fighters and Attack Aircraft,** B. Gunston, Salamada Ltd., ISBN 861010558

**Modern Fighting Aircraft-F14,** Salamanda Ltd, ISBN 0861011945

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**The Fighter Pilots Handbook,** J. Roberts, Arms and Armor Press, ISBN 184509033

# BIBLIOGRAPHY

**The Guinness Book of Aircraft,** D. Mondey and M. Taylor, Guinness Pubs., ISBN 085123554

**The Illustrated History of Helicopters,** M. Heatley, Bison Ltd., ISBN 0861242327

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### Introduction

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### Awards

| | | |
|---|---|---|
| 1990 | F-29 Retaliator | |
| | EMAP | Best Fight Simulator |
| | CVG | Joint Highest Scoring Review/Joint game of the Year |
| | Computer Game World (USA) | Runner up for Best Flight Simulator |
| 1991 | Robocop 3 | |
| | Generation4 (France) | Most Innovative Game and Best Film License Game |
| 1992 | Epic | |
| | Tilt D'Or (France) | Best Computer Game of 1992 |
| | Microkids (France) | TV Award for Best Game of 1992 |
| 1993 | TFX | |
| | Tilt D'Or (France) | Best Flight Simulator |
| | Generation 4 (France) | Best Flight Simulator |
| | Powerplay (Germany) | Nomination for Best Flight Simulator |
| | Computer Game World (America) | Nomination for Best Flight Simulator |
| 1994 | TFX | |
| | PC Losirs (France) | Trophée Argent |
| | Golden Joystick | Best Flight Simulator |
| 1994 | Inferno | |
| | PC Losirs (France) | Trophée d'Or. |

# GLOSSARY

AA - *Anti-Aircraft.*

AA or A-A - *Air-to-Air.*

AAA - Or 'Triple A' - *Anti Aircraft Artillery.*

AAM - *Air-to-Air Missile.*

AA-10 ALAMO - *NATO designation for the R-27*

AA-8 APHID - *NATO designation for the R-60 IR missile.*

AA-11 ARCHER - *NATO designation for the R-73 IR missile.*

AAR - *Air-to-Air Refuelling.*

AAV - *Armoured Amphibious Assault Vehicle.*

AB - *AfterBurner.*

AC - *Aircraft Commander.*

ACA - *Agile Combat Aircraft.*

ACE - *Armoured Combat Earthmover.*

ACM - *Air Combat Manoeuvres - dogfighting tactics involving more than two aircraft.*

ACRV - *Armored Command and Reconnaissance Vehicle.*

AD - *Air Defence.*

ADAM - *Area Denial Artillery Munition.*

ADATS - *Air Defence Anti-Tank System.*

ADI - *Attitude Director Indicator - a cockpit instrument which displays an aircraft's pitch and bank angles relative to an artificial horizon.*

AEW - *Airbourne Early Warning.*

AEV - *Armoured Engineer Vehicle.*

AFTERBURNER - *Part of a jet engine that increases the power of the engine by mixing fuel with the jet exhaust.*

AG or A-G - *Air-to-Ground.*

AGL - *Altitude above ground level.*

AGM - *Air-to-Ground Missile.*

AILERON - *Control surface on an aircraft wing that produces aircraft roll.*

AIM - *Air Intercept Missile.*

ALARM - *Air-Launched Anti-Radiation Missile (BAe).*

ALL-ASPECT - *Weapons that are effective at any angle to the target.*

ALT - *Altitude above sea level.*

AMRAAM - *Advanced Medium Range Air-to-Air Missile - BVR missile.*

AOA - *Angle of Attack - the angle between an aircraft's velocity vector and a reference line pointing straight ahead of the fuselage.*

AP - *Armour Piercing.*

APPROACH - *line-up prior to landing.*

APC - *Armoured Personnel Carrier.*

APHE - *Armour-Piercing High Explosive.*

ARM - *Anti-Radiation Missile, a missile which targets radio-emitting targets such as radar.*

ASARS - *Advanced Synthetic Aperture Radar System.*

ASPECT ANGLE - *the angle formed by a line running directly another aircraft and a line parallel to the other aircraft's longitudinal axis.*

ASPJ - *Advanced Self-Protection Jammer.*

ASW - *Anti-Submarine Warfare.*

ASRAAM - *Advanced Short Range Air-to-Air Missile (BAe).*

AS-7 Kerry - *NATO designation for the Kh-23 A-G missile.*

ATTITUDE - *the state of an aircraft in terms of pitch; bank and yaw.*

ATC - *Air Traffic Control.*

ATF - *Advanced Tactical Fighter.*

ATGW - *Anti Tank Guided Weapon.*

ATM - *Air Tasking Message.*

AUTOPILOT - *A mode in which the flight control computer takes over the control of the aircraft, leaving the pilot with less to do.*

AVIONICS - *Electronic systems in the aircraft.*

AWACS - *Airborne Warning And Control System.*

# GLOSSARY

BAe - *British Aerospace.*

BAI - *Battlefield Air Interdiction.*

BANDIT- *A known hostile of enemy aircraft.*

BANK - *the angle of the wings about the longitudinal axis referenced to horizontal.*

BANK - *To roll the aircraft to one side and induce a turn.*

BEAMING - *flying perpendicular to the emissions from a threat* radar.

BDA - *Bomb Damage Assessment.*

BMEWS - *Ballistic Missile Early Warning System.*

BFM - *Basic Flight Manoeuvers.*

BINGO - *"Bingo Fuel" is the amount needed to RTB (return to base).*

BLACKOUT - *Loss of consciousness due to excessive forces on the pilot.*

BLAST-FRAGMENTATION WARHEAD - *An explosive charge which creates a large amount of shrapnel.*

BLIND - *I do not have the friendly aircraft in sight.*

BLU - *Bomb Live Unit.*

BOGEY - *An unknown aircraft. Become bandits when identified hostile.*

BRACKET - *an ACM tactic in which two (or more) aircraft fly opposite sides of a threat formation.*

BREAK-THROUGH PRESSURE - *pressure needed to overcome the G-limiter on the joystick.*

BREAK - *To suddenly turn in the hope that any enemy following will lose his tactical advantage.*

BUG-OUT - *leave a dogfight.*

BVR - *Beyond Visual Range*

CALLSIGN - *A pilot's or controller's codename.*

CAP - *Combat Air Patrol.*

CAS - *Close Air Support.*

CBU - *Cluster-Bomb Unit.*

CEP - *Circular Error Probability (measure of bombing performance).*

CFPD - *Command Flight Path Display System.*

CHAFF - *packets of foil used to decoy or obscure radar systems.*

COMPASS TAPE - *heading indicator at the top of the HUD.*

CONCUSSIVE - *with violent, if not explosive, force.*

CORNER VELOCITY - *the velocity at which an aircraft achieves its best turn performance.*

CONTINUOUS WAVE RADAR - *A system which emits radio waves continuously, as opposed to pulses (see PULSE DOPPLER RADAR).*

COURT MARTIAL - *A military trial held when breaches of conduct codes occur.*

CTOL - *Conventional Take-Off and Landing.*

DASA - *German AeroSpace Industry.*

DASS - *Defensive Aids Subsystem.*

DEFCON - *Defence Condition. A series of alert conditions set which cause world wide forces to establish escalating levels of readiness and security.*

DLIR - *Downward Looking InfraRed.*

DOGFIGHT - *Engaging enemy fighters.*

DOPPLER RADAR - *Airborne radar which makes use of Doppler effect (frequency shift) in signals reflected from ahead and behind aircraft to give measure of speed over the ground and to distinguish moving targets.*

DROGUE CHUTE - *a parachute released to slow an aircraft, usually when landing.*

DRAG FACTOR - *A number which indicates how un-aerodynamic external stores on an aircraft are.*

DRAG MANOUVER - *decoy manouver to distract fighters away from their targets.*

# GLOSSARY

DURANDAL - *Runway cratering missile.*
EECM - *Electronic Counter CounterMeasures.*
ECM - *Electronic Counter Measures*
ELEMENT - *two aircraft working together as a team, possibly as an element of a larger flight.*
ELEVATORS - *aircraft control surfaces, located at the back of the horizontal stabilisers, which provide pitching moment.*
EO - *Electro-Optical.*
ERA - *Explosive Reactive Armour.*
ESM - *Electronic Support Measures.*
EW - *Electronic Warfare.*
EW RADAR - *Early Warning Radar*

FAB - *Fugasnaya Aviatsyonna Bomba - Russian designation for 'general purpose bomb'.*
FAC - *Forward Air Controller.*
FARP - *Forward Air Refuelling Point.*
FBW - *Fly-by-wire a flight control system which transmits flight commands via wires to servo actuators which drive the ailerons, rudders or other control surfaces. In most FBW systems, pilot input is processed and possibly negated by a flight computer before being sent to the control actuators.*
FCC - *Fire Command Centre.*
FCS - *Fire Control System.*
FEBA - *Forward Edge of Battle Area.*
FIRE AND FORGET - *A missile that once fired, will guide itself to its target.*
FLAK - *Shrapnel produced by AAA shells exploding.*
FLAME-OUT - *stalling of aircraft engine due to circumstances; e.g. bird-strike.*
FLAPS - *Control surfaces on aircraft wings which increase lift for a given flight condition and allow a lower airspeed than is normal in flight.*
FLAPERONS - *a useful control surface that's a cross between ailerons and flaps.*
FLARES - *Pyrotechnic packages which burn with intense heat designed to confuse InfraRed missiles.*
FLASHPOINT - *A trouble zone, be it economic, military or otherwise.*
FLIR - *Forward Looking InfraRed.*
FOD - *Foreign Object Damage.*
FUZE - *an adjustable triggering device in a missile, bomb or other weapon.*

G - *A force acting upon the aircraft and pilot when manoeuvring, expressed in terms of the earth's gravitational force.*
GBU - *Guided Bomb Unit.*
GLCM - *Ground Launched Cruise Missile.*
GLLD - *Ground Laser Locator Designator.*
G-LOC - *G-induced Loss Of Consciousness.*
GPS - *Global Positioning System.*
G-SUIT - *A suit worn by pilots which reduces the effects of high g numbers.*

HARM - *High-speed Anti-Radiation Missile.*
HARD TARGET - *Target which is armoured.*
HARD POINTS - *weapons pylons for carrying anything except fuel (see WET POINTS).*
HAS - *Hardened Aircraft Shelter.*
HE - *High Explosive.*
HEAT - *High Explosive Anti-Tank.*
HE-FRAG - *High Explosive Fragmentation.*
HOTAS - *Hands On Throttle And Stick, which puts all controls at the pilot's fingertips.*
HSI - *Horizontal Situation Indicator - a cockpit indicator which combines a compass with information from an inertial reference system or navigation beacons to indicate relationship of the aircraft with the planned course.*

# GLOSSARY

HUD - *Head-Up Display.*
ICM - *Improved Conventional Munition.*
IFF - *Identification Friend or Foe.*
IIR - *Imaging Infra-Red.*
ILS - *Instrument Landing System*
INDICATED AIRSPEED - *the airspeed shown by an airspeed indicator and not corrected for error due to air density variations caused by altitude and temperature.*
INS - *Inertial Navigation System.*
IR - *Infra-Red.*
IRD - *Infra-Red Decoy.*
IRST - *Infrared Search and Track - an EF2000 system that tracks aircraft and missiles using the heat generated by their engines and by their friction with the air.*

JAMMING - *Confusing the enemy radar by using high-energy bursts of a certain frequency.*
JOUST - EFA - *tactical simulator for evaluation of aerial combat and plane types.*
JSTARS - *Joint Services Tactical RADAR System.*
JTACMS - *Joint Tactical Missile System.*
JTIDS - *Joint Tactical Information Data System.*

KC - *Mid-air refuelling tanker.*
KH-23 - *a radio command A-G missile.*
KIA - *Killed In Action.*
KNOCK IT OFF - *Slang for 'end the mission'.*
KNOTS - *nautical miles per hour.*
KTS - *Abbreviation for Knots.*

LANTIRN - *Low Altitude Navigation and Target Attack System for Night.*
LGB - Laser Guided Bomb.
LIZARD - *A term often used to describe the enemy leader.*
LOAD FACTOR - *the force acting on an aircraft as a multiple of the force of gravity.*
LOCK - *Acquire a target and fix weapons aiming systems on it.*
LOOSE CANNON - A renegade pilot.
LRMTS - *Laser Ranger and Marked Target Seeker.*
LZ - *Landing Zone.*

MACH - *Unit of speed equal to the speed of sound at your altitude.*
MAS - *Manoeuvering Attack System.*
MBT - *Main Battle Tank.*
MEWS - *Mobile Electronic Warfare System.*
MFD - *Multi-Function Display unit.*
MIA - *Missing In Action.*
MiG - *Mikoyan Gurevich - the founders of one of major Russian aircraft design bureaus.*
MMD - *Moving map display - map used for navigation.*
MMS - *Missile Management System.*
MP - *Maritime Patrol.*
MRM - *Medium Range Missile.*

NATO - *North Atlantic Treaty Organisation.*
NAUTICAL MILE - *6,076 ft..*
NAV - *Navigation.*
NBC - *Nuclear, Biological, Chemical.*
NEGATIVE G's - *G-force that forces you out of your seat.*
NOE - *Nap Of the Earth - very low altitude.*
NVE - *Night Vision Equipment.*

ORDNANCE - *bombs, missiles, bullets and other offensive hardware.*
OS - *Offensive Support.*
OTR - *Operational Turn-Round. Rapid re-arming and refuelling of combat aircraft.*

# GLOSSARY

OTH-B - *Over the Horizon Backscatter (radar).*

PGB - *Precision Guided Bomb.*

PINCER - *same as a Bracket manouver.*

PIO - *Pilot Induced Oscillation - oscillation in an aircraft's flight path or attitude caused by a pilot failing to compensate for the lag time between pilot input and aircraft reaction.*

PIPPER - *a small dot at the centre of the aiming reticule.*

PITCH - *the angle of an aircraft's nose above or below the horizon.*

PITCH LADDER - *pitch indicator in the HUD.*

PK - *Probability of Kill.*

POSITIVE G's - *g-force that forces you into your seat.*

PREDICTOR SIGHT - *a computerised gunsight that predicts the flight of the cannon's shells.*

PRESSURE BREATHING - *forced breathing to help cope with high-g manoeuvres.*

PULSE DOPPLER RADAR - *Radar that emits short bursts of radio waves and detects objects by the returning echo.*

RADAR - *Radio Detection And Ranging.*

RECCE - *Reconnaissance.*

REDOUT - *Effect felt by pilot when pulling negative g's for too long. Caused by blood rushing to the head.*

RHWR - *Radar Homing Warning Receiver.*

RHAW - *Radar Homing and Warning.*

RMG - *Ranging Machine Gun.*

ROE - *Rules Of Engagement - rules governing the conditions under which a fighter can engage or fire upon a bogey.*

ROLL - *rotation around an aircraft's longitudinal axis.*

ROOKIE - *Inexperienced pilot.*

RP - *Rocket Propelled.*

RPM - *Revolutions Per Minute.*

RSBN - *a radio navigation beacon.*

RTB - *Return to Base.*

RUDDER - *Control surface on the tail of an aircraft which affects the yaw of aircraft.*

RV - *Rendezvous.*

RWR - *Radar Warning Receiver.*

R-27 - *an advanced Russian A-A radar-guided missile.*

R-60 - *a second-generation Russian heat-seeking missile.*

R-73 - *a third-generation Russian heat-seeking missile.*

SA - *Strike/Attack.*

SA - *Semi-Active. Refers to radar guided missile which requires the radar to illuminate the target all the way to the impact.*

SA - *Situational Awareness - the amount of awareness a pilot has about the tactical environment around him.*

SAM - *Surface to Air Missile.*

SAR - *Search and Rescue.*

SARH - *Semi-Active Homing.*

SEAD - *Suppression of Enemy Air Defences.*

SEMI-ACTIVE - *used to describe a missile which must be guided until its own radar can take over.*

SIDESLIP - *motion of an aircraft to the right or left perpendicular to its longitudinal axis.*

SIX ' CLOCK - *directly behind an aircraft, where it is most vulnerable.*

SLAM - *Stand-off Land Attack Missile.*

SLAR - *Side-Looking Airborne Radar.*

SLATS - *Extendible leading edge high lift devices.*

# GLOSSARY

SLIR - *Sideways-Looking Infra-Red (system).*
SOFT TARGET - *Target without any armour.*
SRAM - *Short Range Attack Missile.*
*separates from the wing surface.*
STALL - *Loss of control due to low airspeed or excessive manoeuvres at high altitude.*
STATUTE MILE - *5,280 ft..*
STEALTH - *ability to avoid detection.*
STUD - *frequency setting on aircraft radio (like presets in a car radio).*

TADS - *Target Acquisition and Designator System.*
TERPROM - *terrain following system.*
TERRAIN HUGGING - *flying at 500 ft or below, following the contours of the land.*
TFR - *Terrain-Following Radar.*
THREAT - *Any enemy in your vicinity.*
THRUST - *Power produced by your engines, usually referred to as a percentage.*
THRUST VECTORING - *the ability to adjust the direction of thrust via movable nozzles.*
TIALD - *Thermal Imaging and Laser Designation (LGB aiming system).*
TID - *Tactical Information Display.*
TOT - *Time-On-Target When you are supposed to be there.*
TOW - *Tube-launched, Optically tracked, Wire-guided.*
TRAM - *Target Recognition and Attack Multisensor.*
TRANSPONDER - *a combined radio transmitter and receiver which transmits a signal when it receives one. Commonly used for IFF systems.*
TRIM - *setting aircraft controls or trim devices so that the aircraft maintains a desired attitude.*
TRIM TAB - *a small control surface attached to an aileron of other larger control surface for the purpose of making small trim corrections to that surface's position.*
TRUE AIRSPEED - *indicated airspeed corrected for installation, compressibility and air density errors.*
TWS - *Track While Scan radar mode.*

VASI - *Visual Approach Slope Indicator system of lights for landing assistance.*
VELOCITY VECTOR - *an indicator in the HUD which shows predicted path of travel.*
VERTICAL VELOCITY - *the sink or climb rate of an aircraft.*
VIRTUAL COCKPIT - *true 3-D scrolling, panning cockpit.*
VSI - *Vertical Speed Indicator.*
V/STOL - *Very Short Take-Off and Landing.*

WAYPOINT - *A position in the world to which you have to fly.*
WCS - *Weapon Control System.*
WET POINTS - *places on the plane where external fuel tanks can be mounted.*
WILD WEASEL - *jamming mission, specifically against enemy air defences.*
WINGMAN - *A flying partner.*
WIRE - *The correct flight path for weapon delivery.*
WP - *WayPoint.*

YAW - *rotation of aircraft about its vertical axis.*

ZERO-ZERO EJECTION - *ejection at zero altitude and zero speed.*

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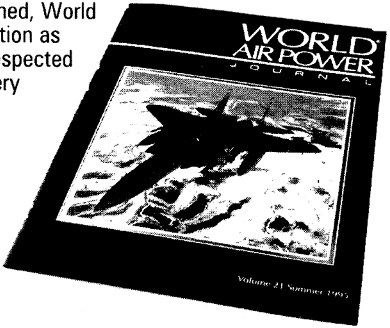

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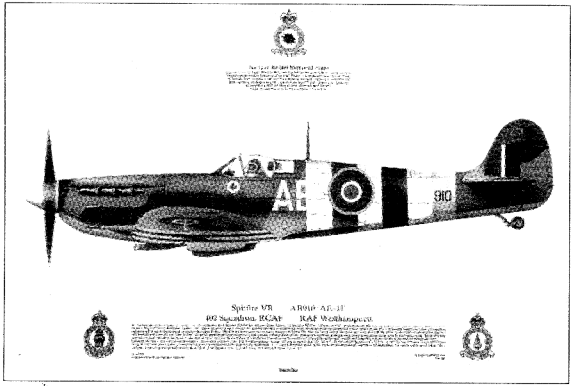

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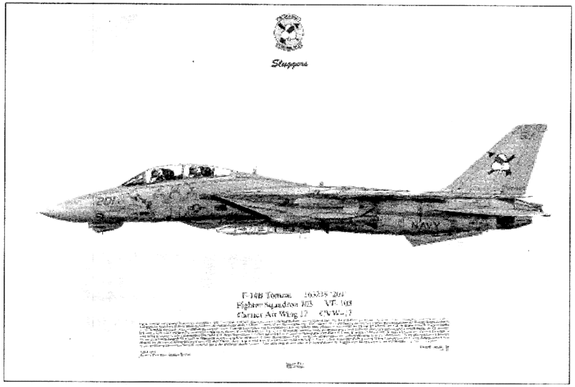

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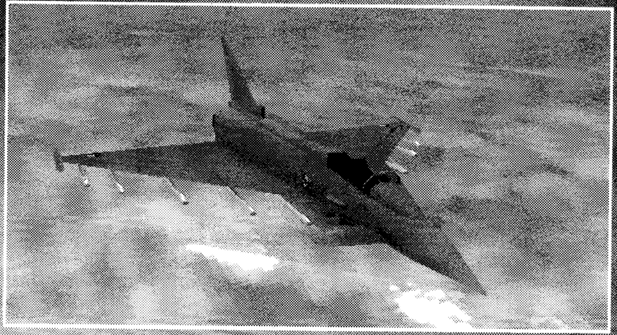
The Military FlightSim Magazine

*Eurofighter2000*



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